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THE
SCHOOL of WISDOM,
OR, NEW
PRECEPTOR.

РРЕСЕТОР

ART. 1. NAT. URE.



INSTRUCION

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Price Three

SCHOOL of WISDOM,

O R, N E W

PRECEPTOR:

A general SYSTEM of the WORKS of
ART AND NATURE,

Calculated for advancing the

INSTRUCTION OF YOUTH,

CONTAINING

- | | |
|---|---|
| I. DEFINITION of the SOUL, and DESCRIPTION of the HUMAN BODY. | VI. On DRAWING, DESIGNING, PAINTING, LIMING and GILDING. |
| II. ASTRONOMY, ORATORY, MORALITY, and the Principals of POLITENESS. | VII. On ETCHING, ENGRAVING, BRONZING, STAINING different SUBSTANCES, &c. |
| III. GENERAL REVIEW of the WORKS of the CREATION, viz. BIRDS, BEASTS, FISHES and INSECTS. | VIII. On DYING, with general RULES for the different COLOURS. |
| IV. On the TERRAQUEOUS GLOBE, VEGETABLE CREATION & ELEMENTS. | IX. On FIRE-WORKS, with DIRECTIONS for making the different SORTS. |
| V. COMPARATIVE VIEW, and REFLECTIONS ON NATIONS, MANNERS and MEN. | X. Of the ART of making PORCELAIN, after the CHINESE MANNER, SECRETS in METALS, &c. |

COMPILED FROM VARIOUS AUTHORS.

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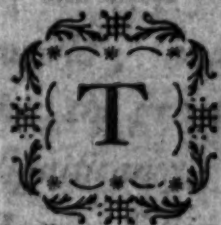
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THE
PREFACE.



THE COMPILERS of the
SCHOOL of WISDOM beg
leave to solicit the candour
of the Public, hoping they
will excuse any little inad-
vertencies which may appear in this
Work; as multiplicity of business, and
the impatience of the SUBSCRIBERS,
prevented them from correcting it in
the most exact manner. But, 'tis pre-
sumed, that considering the variety of
subjects with which this book abounds,
some will be found amply to compensate
for the errors in others: Should any
chuse to criticise on this performance,
we hope they will be candid, and re-

iv The P R E F A C E.

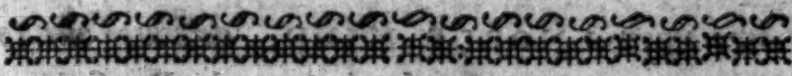
commend the passages worthy of notice,
and expose the faults with regret; for,

Whoe'er expects a faultless piece to see,
Thinks what ne'er was, nor is, nor e'er shall be.

Should we be so happy as to meet
with the Approbation of men of genius
and learning, we shall disregard the re-
marks of the snarling Critic, and smile
at the attacks of the Pedant. Hoping
to enjoy the favor of the generous Pub-
lic, whose rational amusement we have
endeavoured to promote; for their libe-
ral Contributions, they have the sincere
Thanks of

Their
Most obedient Servants,

The EDITORS.



INTRODUCTION.

K NOW THY SELF! *was*
an Inscription over the Gates of one
of the most famous Temples of the Heathen
world; and it has been ever since admired
for the great importance of it, and its vast
significancy, tho' express'd in so few words.
Let us follow this sage advice, by consider-
ing what we are, and what is around us.
Let us open the Eye of the Mind, as well as
those of the body; and, whilst the one is
charmed with beholding, let the other be no
less so, with contemplating, THAT ALL IS
GOOD AND WISE. For, what is M A N
without Education? like Marble in the
Quarry, till the Skill of the Polisher makes
the Surface shine, and discovers every orna-
mental Cloud, Spot and Vein, which runs thro'

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the body. INSTRUCTION, when it affu-
ates upon a NOBLE MIND, *draws out to*
View every latent Virtue and Perfection.
The Senator, Philosopher, and Mechanic,
very often lie conceal'd in persons of low con-
dition in Life, which a proper Education
might have dis-interr'd, and brought to
Light. The HUMAN MIND always repays
us with USURY *for the CARE we take to*
 CULTIVATE it: 'tis a Soil that is RICH
 AND FRUITFUL, capable of the most NO-
 BLE PRODUCTIONS—therefore worthy of
our Care. Finally, INSTRUCTION dispels
the Cloud of Ignorance, enlarges the Mind,
extends its Views, multiplies its Ideas, and
opens to it NEW SCENES OF PLEASURE,
which those that want Education, can never
enjoy. And, as Wisdom and Virtue are es-
 sential to our Happiness; PRACTICE WELL
 WHAT WISDOM DICTATES, AND VIR-
 TUE SHALL REWARD YOU.



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THE

SCHOOL *of* WISDOM, &c.

C H A P. I.

Of the SOUL of MAN.

AS the Soul of Man is his most noble part, being a copy of the Divine Image in us, in which we have enough to fill us with admiration of the munificence, wisdom and power of the infinite Creator, when we contemplate the noble faculties of this our superior part, the vast reach and compass of its understanding, the prodigious quickness and piercingness of its thought, the admirable subtilty of its invention, the commanding power of its wisdom, and the great depth of its memory, we must be astonished at the immense power of that WISE BEING, who formed every part of this grand Creation. There are two things we cannot easily pass by, because they manifest the special concurrence and design of Providence, as having a particular and necessary tendency to the management and good order of the affairs of mankind in general. How various are the inclinations of Men, to differ-

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ent businesses; we see how naturally they betake themselves to this and that employment; some delight in divinity, some in physic, anatomy, and botany, some in critical learning, and philology; others in mathematics, metaphysics, architecture, war, navigation, commerce and agriculture, while many more are busied in the servile offices of mankind, beyond numeration.

Now all this is necessary, for the more easy transacting the affairs, foreign or domestic, of almost every individual of the human species; to answer every end and occasion of Man; to make him useful even to the poor helpless beasts, as far as his help is needful to them; all without any great trouble, fatigue, or inconvenience; but rather as a pleasure and diversion to him: for so far it is from being a toil, that the greatest labours, cares, and dangers become pleasant to him who is pursuing his genius; whose ardor eggs him forward, and buoys him up under all opposition, and carrieth him through every obstacle, to the end of his designs and desires.

In the next place it is highly worth our observation to note the inventive power of the Soul; to shew how astonishing it is, that it should hit upon every thing, that is, or may be of use to himself or society, in which he has such extensive interest and concern. For the illustration of this, we shall take a cursory view of the arts, sciences and trades, and the very tools they perform their labours and contrivances with, which are numerous as their various occasions require.

What is there that falleth under the inspection of man's Senses, that he doth not employ to some use or purpose, for either private or public good? The Celestial Bodies, the sun, moon, and other planets, he employs to the noble purposes of astronomy, navigation, and geography. What an abundant mass of knowledge must the Soul be endowed with, to invent the useful sciences of geometry and arithmetic, both

specious, and in numbers; and those nice and various instruments, made use of by the geometrician, astronomer, geographer, and sailor! What wonderful sagacity is shewn in the business of optics, particularly in the late invention of the telescope; wherewith new wonders are discovered among God's works, in the Heavens; as there are here on Earth, with the microscope and other glasses! And as for this lower world, what material is there to be found; what kind of earth, stone or metal; what animal, tree or plant, and the very shrubs of the field; in a word, what, of all the excellent variety of things the Creator has furnished the world with, for all uses and occasions, in all ages, that Man's contrivance doth not extend unto, and make some way or other advantageous to himself, and useful for building, cloathing, food, phylic, tools or utensils, or even only for pleasure and diversion! But now considering the power and extent of Human art, there are others things which further demonstrate the superintendence of the Great Creator; and we find, that things of great and absolutely necessary use have soon, and easily occurred to the invention of man; while those of little use are rarely and slowly discovered, if ever.

We have as early as the Mosaic history an account of the invention and progress of the more useful occupations: thus (GEN. iii. 23.) Adam was sent forth from the garden of Eden, by God himself, to cultivate the earth; and in the next chapter his two sons Cain and Abel were differently employed, Cain was a tiller of ground, the other a keeper of sheep. Jabal was father of such as dwell in tents, (GEN. iv.) that is, he was the inventor of tents. Tubal Cain was an instructor of every artificer in brass and iron, or the first that found out the art of melting and malleating metals, making them useful for tools, and other necessary implements: his sister Naamah is also said to have invented spinning and cloathing. Yea, the very art of music is thus early ascribed to Tubal,

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(GEN. iv. 21.) so indulgent was the Creator to find means to divert melancholy, to cheer the spirits, and to entertain and please mankind. We may learn from hence, that matters of less concern, and those of dangerous consequence, were for our instruction, left exercises of the wit and faculties of men.

What an excellent property of the Soul is the Memory, what a vast variety of things does it retain! Tho' we are every day crowding it with fresh objects, yet it still preserves those committed to it many years past; who can comprehend where where it lays up all these things? by what means doth it retain, and keep them separate and distinct, so as not to confuse each other? it holds a multitude of of actions within its narrow compass, and yet presents to us each single one distinct and clear, whenever we have occasion to recall it. It is a guardian and trustee of all we see, hear, read, and of all that our own reflections teach us: 'tis a domestic and natural treasure of exquisite value: the monuments of the history of nations have bounds, but the memory of man has none; it joins one history to another. What it has once admitted in good order (especially when it retains any object with the strong ties of reasoning and pleasure) is a deposition it preserves for us all our lives. What is most to be wonder'd at, is the perspicuity that is maintained among these images, which no length of time, nor change of situation, can possibly efface or embarrass. If we are shewn the picture of man we have not seen for twenty years together, 'tis a doubt but we immediately find many faults with it, yet probably do not think it altogether unlike the original; that the mouth is too wide, the turn of the face is too much upon the round, and that the eye is too full and looks sad. Those who have lived with the man we speak of, will find our judgment is right; but where is the voucher that can authorize this censure? it is another more faithful and indelible portrait, which the bare sight of

The SCHOOL of WISDOM. 5

that man has left in the memory, and which a million of other pictures, could by no means hinder from distinguishing directly. It is that enriching faculty the Memory that so seasonably supplies us with the discoveries of the greatest genius's in every age; with the ravishing strokes of the most eloquent orators and ingenious poets; the reflections of men deep in penetration, whom a long experience has made perfect; in short, with whatever they have been able to collect, in consequence of their own remarks, or by means of others.

We experience in our memories a kind of convenience, never met with in any common magazine; in the latter we are oblig'd to refer to some particular mark or number in order to produce the matter contended for; whereas with the memory it is the reverse, for if we want to recollect any thing, the ideas themselves offer their service; that which immediately concerns him, after it has minister'd to him, disappears in his turn, tho' still ready to shew itself again upon every new command. When we consider what amazing things many men have done, we can no less be astonished at the excellency of our nature: what a vast capacity did it require, to discover the mode of expressing every meaning and thought of our minds, by the use of twenty-four characters or letters; and to express all numbers by the application of only ten figures!

If we consider some men in particular, we shall be no less astonished King Mithridates made himself master of no less than twenty-two different languages; the famous Origen composed no less than six thousand books; Pliny, in collecting his natural history, consulted above two thousand different authors; the memory of Cyrus was so great, that he called every man in his prodigious army by his right name; Seneca could repeat two thousand names, in the exact order they were spoke, only once hearing them; Leonardo de Vince, by the as-

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sistence of an extensive memory, made himself so great a proficient in his profession of history and painting, that none ever went before him; and yet he was skilled in sculpture, architecture, mathematics, mechanics, &c.

Who but the Omnipotent could make such a divine substance, endowed with those admirable faculties and powers, as the rational soul hath? a being so fashioned as to bear the Creator's vicegerency in this lower world; to employ the several creatures; to make use of various materials; to manage the grand business of the creation; and to survey the glories of all the visible works of a God! a creature, without which this lower world would have been a dull, uncouth, desolate globe: who, or what less than the infinitely wise Being, could form such a rational creature, such a divine substance as the soul! for suppose we should allow the atheist any of his nonsensical schemes, the epicurean his fortuitous concourse of atoms, or the cartesian his created matter put in motion; by what means could he, in his way, produce such a divine substance, endowed exactly with such faculties, powers, and dispositions, as the various occasions of life require from such a creature! Why should not rather all the arts, the dispositions and ingenuities of men, if made by a mechanical process, and not by the Deity, have been more nearly alike? particularly, why should not each have thought upon every advantage of equal use, as another, many ages since? Why not that man have effected as well as this some thousand years after? why also should not all nations and all ages improve in every thing as well as this or that age, or nation only? Why should the Greeks, Arabians, Persians, or Egyptians of old, so far exceed those of the same nations, at this late period? How could it come to pass, that the use of the magnet, the art of printing, making clocks, the invention of telescopes, and a great number

The SCHOOL of WISDOM. 7.

of other artifices, should escape the discovery of Archimedes, Anaximenes, and many more celebrated virtuosos of the early ages, whose contrivance of various engines, spheres, and other curious instruments are recorded? Why cannot the past (or the present) age, so eminent in the different branches of polite learning, for improvements in all arts, (perhaps excelling any age of the known world) discover those hidden *quaesita*, which may probably be reserved for the discovery of future and less learned generations? Of these weighty matters, no satisfactory account can be given by any mechanical hypothesis, or other form, without taking in the superintendence of the universal Ruler of the world, who manifests himself sufficiently in the most considerable works of men, by numberless instances of his unexampled goodness, or by some remarkable transaction of his providence, set forth as a token of his love for the soul.

Let us therefore follow the advice of Solomon, (ECCLES. ix, 10.) Whatsoever thy hand findeth to do, do it with all thy might; lay hold on every occasion that presents itself, and improve it with the utmost diligence: because, now is the time of action, both in the employment of the body and of the mind, now is the season of studying either arts and science, or wisdom and virtue; for which we shall have no opportunity in the place whither we are going in the other world; for there is no work, nor device, nor knowledge, nor wisdom, in the grave whither thou goest.

CHAP.

CHAPTER II.

A particular Description of the HUMAN BODY.

WE have perhaps possessed a body for a number of years, and yet not once thought what a wonderful composition that body is. We eat, drink, sleep, draw in the breath of life, feel our blood circulate, walk, stand still, lie down, rise again, speak with our tongue, hear with our ears, see with our eyes, smell with our nostrils, taste with our palate, feel all over our body, and probably not once reflected, how admirable all these are, and what a grand display of judgment has been shewn in forming and disposing them for use; and still what a subject for reflection is here!

How surprizingly curious is the structure of man's Body; what a pleasing variety of the most exquisite modes of workmanship are exhibited in this moving machine of ours, where all the parts are so exactly correspondent, as to answer the great purpose which they originally were intended for! What a commodious posture for a rational creature is the erect position of the body of Man; for without this form, he could not readily have turned himself to perform his various necessary offices, much less to exercise his faculties among the curiosities of nature and art. His hand, particularly, could not have been in such great readiness to execute the commands of the will, and dictates of the soul; his eyes would have been the most prone to danger, and incommodiously situated of all animals; but by this situation, he can cast his eyes upwards, downwards, and round about him; he hath a glorious hemisphere of the heavens, and an ample horizon on earth, to entertain his eye.

The SCHOOL of WISDOM. 9

The figure and shape of man's body, is the most commodious that possibly could be devised for such an animal ; the most agreeable to his motion, to his labours, and all his occasions. For had he been a rational reptile, he could not have moved from place to place, fast enough for his business : had he been a rational quadrupede, among other things he would have lost the benefit of his hands, those noble instruments of the most useful performances of the body. As in the figure, so in the stature and size of man's body, we have another manifest indication of Excellent design : that is, not too pigmean, nor gigantic ; either of which proportions would have been very inconvenient, both to himself and his business, or to the rest of his fellow creatures. Too pigmean would have render'd him too puny a lord of the creation ; too impotent and unfit to manage the inferior creatures : besides, he would have been expos'd to the assaults of the weakest animals, to the ravening appetite of voracious birds, and endanger'd his being trodden to death by any animal of greater bulk than himself. On the other hand, had man been enormously gigantic, it would have given him an opportunity of executing the greatest acts of tyranny ; and perhaps might have been too strong in some respects, even for his own kind, as well as others. Locks and doors might have been made of sufficient strength to barricade our houses, walls and ramparts strong enough to defend our cities ; but these things could not have been performed without an enormous and inconvenient expence of room, materials, and such necessities, as such large structures would require ; more, undoubtedly, than the world could have afforded to all ages and places. No other cause can be assigned, why Man was not made bigger than he is, but his relation to the universe.

What a noble situation is that of the Head, which is placed as on an eminence, being the most proper

station possible for the repository of the four Senses, three of which we shall chiefly describe: the fourth, namely the Eye, being endued with so many excellent properties, we shall treat of that curious organ of the Human species, separately from any other subject.

The sense of Hearing is deposited in the most convenient part of the body, near the common sensory the Brain, to give the more speedy information; in a part where it can be best guarded, and where it is most free from annoyances and harms; and where it gives the least hindrance to the exercises of any other power; in a place appropriated to the peculiar use of the principal senses, in that lofty eminence, where it can receive the most intelligence, and judge with the nicest observation. There is a discreet portion of the Creator's providence in the substance of the outward Ear, which is hard and horny; if it had been bone, it would have been troublesome, and liable by many accidents, to break off; if flesh, it would then have been subject to contusion, and would neither have remained suspended, nor so kindly receive and circulate the sounds, but absorb, retard, and blunt their progress into the inward organ: but being hard, and curiously smooth and tortuous, sounds find an easy passage, with a regular volutation and refraction; as in a well built arch, grotto, or musical instrument, which magnifies and meliorates sounds; and some of which convey even a whisper to a greater distance. The Hearing is always open, it is a sense we need even while we are sleeping; for if any sound enters, we awake. If the passage into the ear had been straight, the sound would dissipate and escape before the sense could be affected: and, to prevent the invasion of noxious insects, Nature hath secured this passage with a bitter nauseous excrement, afforded from the glands appropriated for that purpose. There is also a special contrivance of the nerves, ministering to this sense of Hearing,

which may not be unworthy of notice : and that is, the branches of one of the auditory nerves, spread partly to the muscles of the Ear, the Eye, the Tongue and instruments of Speech, which are inoculated with the nerves to go to the Heart and Breast; by which means there is an admirable and useful consent between those parts of the body, it being natural for most animals, upon hearing any uncouth noise, immediately to erect their ears, and prepare them to catch every sound; to open their eyes (those constant faithful centinels) to stand upon their watch; and to be ready with the mouth to call out or utter what the present occasion shall dictate, to guard them from external dangers. There is besides this in Man, another great use in the nervous commerce, between the ear and the mouth; that the voice may correspond with the hearing, and be a kind of echo thereof, that what is heard with one of the two nerves, may be readily expressed with the voice by the help of the other.

As the sense of Smelling is particularly useful shall make a few remarks on that subject, which may suffice, because its apparatus (altho' sufficiently grand and admirable) has not such a multiplicity of perfections as the eye and ear; it being sufficient in this sense, that the odoriferous effluvia of bodies can have a free passage to the olfactory nerves, without the formalities of refraction, and other preparations necessary for the perfection of the two former senses. Accordingly the beneficent Creator hath made sufficient provision for the reception of smells, by the aperture of the Nostrils; made not of flesh, or bone, but cartilaginous, the better to be kept open, and withal, to be dilated or contracted, as there is occasion, and for which purpose it hath several curious and proper muscles. The nostrils are placed high, because all scent ascends, and have with great reason, a near vicinity with the mouth, as they assist us in judging of meat and drink, and are either partly open; there is

another excellent property in the lower part of the Nose, being easily moveable, having a set of muscles to lift up, open or shut the nostrils, and so adjust it to every occasion of sense, as far as is requisite : and as a farther guard against the ingress of noxious things, Hairs are placed at the entrance of the nostrils, which in some measure stop the entrance of things improper, or at least give warning of them. They have also a humidity necessary for repelling dust and other extraneous bodies.

The Taste, which is to distinguish the quality of what we take, is in that part of the mouth where nature has laid open a passage for what we eat or drink. The all-wise Creator seems to have established a great consent between the Eye, the Nose, and Tongue, by ordering the branches of the same nerves to each of those three parts ; and indeed to divers other parts of the same body, by which means, there is all the guard that can be, against pernicious food ; for before it is taken into the stomach, it must undergo the trial of three of the senses viz. the scrutiny of the Eye, the street surveyor of its outward appearance ; and the probation of the Smell and Taste, the two severest judges of its natural constitution and composition.

What a variety of uses hath Nature laid upon that active member the Tongue ! the grand instrument of taste, the faithful judge, the centinel, the watchman of all our nourishment ; the artful modulator of our voice, the necessary servant of mastication, sucking, swallowing, and various other uses.

What an instance of contrivance in our bodies, that the sense of Feeling is placed in no particular part, but equally diffused through the whole structure, that we may not receive any blows or too rigid attacks of cold and heat, without being sensible of them, and so be warned to defend ourselves. This sense of feeling is perform'd by nerves, spread in the most curious manner, throughout the whole body. Thus in the

senses of animals we have a wise economy worthy of the Creator, openly demonstrating his power, wisdom, and indulgence. As the offices of respiration are necessary to our existence shall just mention one prodigious work of nature, and that is the circulation of Blood in the Fœtus in the womb, so different from the method thereof after it is born. In the womb, while it is one body with the mother, and hath no occasion nor place for respiration, there are two passages on purpose for the transmutation of the blood, without passing it through the lungs; but immediately after the fœtus is born, and thereby becomes a perfectly distinct being, these two passages are shut up; one nearly obliterated, the other becomes a ligament: What is Thought and Contrivance, if this be not? namely, that there should be a temporary part of the Body, made just for the present exigence; to continue whilst there is occasion for it, and to cease when there is none.

How excellently we are defended against injury in the Throat or Gullet, as the passage, for the entrance of the air we breath into the lungs, is placed near that whereby we swallow our food: What imminent danger should we be in, by every morsel of nourishment we take, in stopping our breath, had not God (whose goodness extends to the minutest particular) made a little lid or cover over the passage thro' which we receive our breath- which constantly shuts down of itself; and with such wonderful exactness and care does it execute its office, though we have occasion for it ever so often, it has rarely, if ever been known, that any accident has happened to mankind this way.

Again, what provision there is made in the Stomach for digesting our food, and to make it nourish the whole body! how amazing the perpetual motion of the Heart, which drives the blood to every part of the body; for if it ceases one moment, life would be immediately extinguished! What matter

of surprize do they find who have seen a human body dissected! to see what a vast number of inconceivable fine veins and arteries are there contained that sustain the interior parts of such a noble edifice! What infinite wisdom is shewn in the continual play of the Lungs, which alternately dilate and contract, to receive and return the air we breathe.

We shall pass by the particular conformation of many parts (the Ligaments and Fastenings) the better to complete our design, for instance, of the Pericardium to the Diaphragm (which is peculiar to Man.) As an explanation would take up more pages than this treatise will admit, the variety of subjects considered, and those technical terms little understood by some of our Readers, therefore we shall proceed to describe as before, such parts of the Human Structure, as shall display the wisdom of God in so intelligent a manner, that the meanest capacity may both understand and admire.

Let us next examine the curious fabrick of the Bones, those pillars of the body, how artificially made: What so commodious a texture could have been given them, to be so firm, strong, and light? Who could have shaped them so neatly, and adapted them to every part, to be of such use; made them of such exact lengths, given them such proper sizes, and shapes; channelled, hollowed, and headed them in so complete a manner? How artfully are the joints contrived to render our limbs pliant and fit for every motion, their bandage keeping them from luxation; the oily matter to lubricate them, and their being so smooth, that notwithstanding their being in use for fifty years, they are not injured by so long and nearly a perpetual motion. How curiously placed are the bones from head to foot! the vertebra of the Neck and Back bone made short and complanated, firmly braced with muscles and tendons for easy incurvation of the body; but withal for greater strength to support its own weight, together with other additional

weight it may have occasion to bear. The Thigh bones long, of great strength, and every way well fitted for the various motions of the body. The Feet are accommodated with a great number of small bones, curiously and firmly tacked together; to which also must be added the assistance of the muscles, to answer all the motions of the legs and thighs, and at the same time to keep the body upright, and prevent its falling by readily assisting against every vacillation thereof; and with frequent and easy touches it keeps the line of innexion and centre of gravity in due place and order. And as the Bones are adapted to prop, so all parts of the body are as incomparably placed to poise it, not one side too heavy for the other, but all in a just equipoise: The shoulders, arms, and sides equilibrated on one part; on the other, part of the viscera of the belly counterpoised with the weight of the scapular part, and that useful cushion of flesh behind. To all this we may add the wonderful concurrence and ministry of the prodigious number and variety of muscles, what service they are to us in running, leaping, dancing, and every other exercise.

Next, let us consider the Lodgment of the curious parts of man's body, which is no less admirable than the parts themselves, all set in the most convenient places, in order to accomplish their own several purposes and designs; mutually to assist and help each other. Where could the eye, the ear, and tongue, be so commodiously fix'd as in the Head, so near the Brain, a part well guarded, and of little use than to be a seat to those senses? Where could we place the hand to be so useful on every occasion, but just where it is? There is a very curious particularity in the hand which renders it of great utility to man, viz. the difference in the length of the Fingers; for by this contrivance, when we grasp any thing of a large circumference, the ends of them come to an equal length, whereby we are ena-

bled to take firmer hold : they are equally serviceable in holding small things between our fingers, which otherwise would have been apt to slip away. These and many other inconveniencies should we have experienc'd, had our fingers been formed otherwise than as they are. And such is the flexibility of our joints, that the fingers are clos'd and open'd without any difficulty ; so that by their help, the hand is enabled to perform all the offices of life ; for it is with the hand we till the ground, plant trees, build houses and palaces, and fetch from all parts of the world, every commodity of life.

Where could we lodge the Heart, but in or near the centre of the body ; where find room for that noble engine to play freely in, guarded as it is against external harms, but in the very place where it is so well secured ? Is it possible to fix all the arteries and veins to convey nourishment, and the nerves sensation, throughout the body in a better manner than their present situation will admit of ! The most magnificent and ingenious pieces of mechanism that ever were invented by human art, are far inferior to this single structure. Where could we set the Legs or Feet, but where they are, to bear up and handsomely carry about the body ; What covering, what fence could we find out for the whole frame, better than that of Nature's own providing the Skin ? How could we shape it to, or brace it about every part of us either better for convenience or ornament ? What better texture could we give it, which, altho' less obdurate and firm than that of some other animals, yet is so much the more sensible of every touch, and more compliant with every motion, whether circular, direct, violent, swift or slow ? And being easily defensible by the power of man's reason and art, is therefore much the properest tegument for such a reasonable creature.

Here we might have put an end to our observations relating Man, but that there still are three things so

expressly declaring the Divine management and concurrence, and being of so important a nature to Man, that we cannot omit mentioning them (although more amply taken notice of by others) and that is, the great and serviceable variety throughout the world of men's Faces, Voices, and Hand-writings. Had man's body been made according to any of the Atheistical schemes, or any other method than that of the Omnipotent, this wise variety would never have been; but men's faces would have been alike, and cast in the same, or not a very different mould; their organs of speech have sounded the same, or not with so great variety of notes; and the same structure of muscles and nerves would have given the same direction in writing. In this case, what confusion, disturbance, and mischiefs, would the world continually have lain under! No security to our persons, no certainty nor enjoyment of our possessions; no justice between man and man; no distinction between good and bad, of friends or foes, father and child, husband and wife, male or female; but all would have been exposed to the malice of the envious and ill-natur'd, to the fraud and violence of knaves and robbers, to the forgeries of the crafty cheat, to the lust of the effeminate and debauched! our courts of justice can abundantly testify the dire effects of mistaking men's faces, of counterfeited hands and forged writings. But now, as the infinitely wise Creator and Ruler hath order'd the matter, every man's face distinguisheth him in the light; his voice in the dark, and his hand-writing can speak him sufficiently though absent, and be his witness and secure his contracts to future generations: a clear demonstration of the Divine superintendence and care.

Lastly, whether we consider the bare mechanism of the organs, or the use and convenience of each sense and faculty, we find it noble, grand, curious, and artificial; every way worthy of its beneficent Maker,

and beyond the wit and power of any thing but a God.

LET us now consider that noble organ of sense the Eye; which (says a celebrated Anatomist) for its excellence, may be called the Miracle of the CREATOR.

Among the principle parts of the body which shew the wisdom of God, none is found that shines with greater grandeur, or more elegance and beauty than the Eye, which seems to have a peculiar care and distinction bestow'd upon it by the Divine Being, and displays the highest marks of his stupendous power. The learned have declared, that nothing can be added thereto or alteration made, either for beauty, safety, or usefulness.

To enumerate all the wonders of the Eye, would swell this treatise to an enormous size, therefore we shall endeavour to explain its admirable properties in such a manner, as an ordinary capacity may understand, and the most learned admire.

This magnificent structure is entirely disposed according to the nature of light. It is certain that we see no object, but by its being drawn by the rays of light reflected from it, on a very fine skin which is placed at the bottom of the eye, called the *retina*: upon this thin membrane or skin, the light of pictures imitably, the image of the sun, moon, stars, or whatever object we look at, are represented in their true colours and lineaments. But who can conceive how this is to be done? that a multitude of different objects should all be pictured at the same time, and each distinctly within the small compass of the Eye! and yet this is a fact; tho' beyond our comprehension. Let us but examine and reflect, and we must admire the enchanting prospects we behold from eminences;

of hills and vales, fields, trees, rivers, woods, and other objects, minutely drawn within the narrow limits of this curious fabrick.

The Humours of the eye are particularly suited for the purpose of drawing together the rays of light; for when they enter the eye, they meet with a fine humour, called the *aqueous* or watery humour, because it is in all respects like water, except that it will not freeze even in the greatest frosts. In going thro' this humour (such is the property of it) the rays of light are turned out of the course they were going in, and brought nearly together, till they come to the second humour of the eye, called the *crystalline* humour, which is a transparent solid substance, convex or projecting outwards on both sides; which unites all the rays on the bottom of the eye: Experience shews, that this form is the properest for uniting rays of light into one point. Thus we find that a flat piece of glass has no power to unite the rays of light, but if the same glass is ground convex, (like glasses of spectacles) we find it will gather the rays into one certain point, and represents the exact image of all objects that are before it; so that by the help of a glass ground convex, or even a common spectacle glass, we may see exactly how every thing passes in the eye, how curiously it is contrived for the purpose it was intended, and how sight is performed. To do this, we need only make any chamber that has a prospect before it as dark as we can, then cut a round hole through the window shutter something smaller than the circumference of a spectacle glass; then (the case or fash being open) place such a glass exactly before and close to the hole, taking care that the light has no other passage into the room; then if you hang a white cloth or sheet of paper upon the wall at a proper distance from the glass, so that the rays proceeding from every point of the objects, may each of them be collected into its correspondent point, you will perceive the image of every thing without

the chamber, will be painted in the most perfect manner upon the cloth or paper, according to all its lineaments and colours, especially if the sun happens to shine upon the external objects, and the glass be in the shade; for instance, when it happens that the sun is in the south, and the window in which the glass is, stands towards the north, so that none of the sun's rays come directly upon it, it will be necessary to move the paper or cloth near to or further from the window, till it is brought to the exact distance where the rays meet in a point, then every object on it will appear perfectly clear and distinct. This method justly explains the nature of the eye; the hole in the window-shutter represents the pupil, the crystalline humour performs the same as the spectacle-glass placed before the hole; the dark room is a true representation of the cavity in the eye, and the retina or thin membrane which is placed at the bottom of the eye, is for the same purpose, and receives the images of all objects that come before it, just in the same manner, as the white paper or cloth receives the images of all objects that come before the glass.

By way of experiment, take the eye of an ox newly killed (while it is warm) and placing it before the hole of a dark chamber, instead of a spectacle glass and it pictures the images on the paper in the manner as before described: they who have time to examine it nicely, may see the objects painted on the retina of such an eye, in the same manner as they are upon the paper; this last experiment requires skill and trouble, which the first shows equally as plain. Thus we find a flat piece of glass will have no effect, and that the moment the convex or spectacle glass is taken from the hole, no distinct objects appear on the paper: in the same manner, had the sight been flat instead of convex, or had not there been that double convex substance called the crystalline humour in it, tho' the eye had remained the same in all other respects, yet it would not have distinguished any thing so clearly;

and to preserve this convexity so necessary to sight, God not only made the eye of a convex form, but placed in it a transparent fluid, called the aqueous or watery humour; which, besides refracting or bringing together the rays of light, fills out the sight of the eye, making it of a convex form. This humour is so very necessary and there is such a sufficient quantity, that if by any accident of a wound or puncture made in the eye it is entirely let out or lost, nature supplies it again, so as to restore sight to the eye.

Galen relates of a boy whose eye was so wounded, that the aqueous humour was quite lost, whereby the convexity of the eye became flacid; but yet he, after some time, recovered his sight.

It was not only necessary that the eye should be convex, but that it should be so to such a particular degree and no farther; for if it be too much so, it gathers the rays of light together before they reach the retina, and consequently can imprint no image there, or a very indistinct one; and we find that an eye of this sort cannot see any thing at a distance, therefore such are called short-sighted, because they are obliged to hold what they see at a small distance from their eyes, that the rays of light reflected from it may not be gathered into a point, till they reach the bottom of the eye. For objects afar off, they use a glass ground concave or hollow on the inside, which has a very different effect from spectacle glasses, for instead of gathering the rays of light together, it scatters them, and by that means lessens the effects of the too great convexity of the eye.

There are yet remaining many remarkable peculiarities in the eye, necessary to be explained; one is, though all the limbs, muscles, nerves, arteries, veins, and most other parts of the body, grow continually till the state of manhood is attained, yet the *crystalline humour* never grows, but always preserves the same size and form, both in men and children.

The pupil of the eye is not only formed of that due and exact dimension fittest for sight, but, (which is still matter of higher astonishment,) that as we have occasion to see objects, sometimes in a greater, others in a lesser light, in order to admit more or fewer rays, according as will best serve our sight: if the light be too great, it becomes smaller in order to exclude what is superfluous; but if the light is too faint, or the object we look at is at a distance, it becomes larger, that it may take in a greater number of rays in proportion.

That this enlarging or lessening the pupil of the eye is not owing to our own judgment or will, we may be convinced of, by placing a candle before the eyes of an infant; when we may observe, that the pupil of the infant's eye will contract of itself, or become much less, in order to exclude the too great light; but let the candle be withdrawn, or removed aside, we may find the child's pupil by degrees to become larger; but let it be withdrawn to a still greater distance, and the pupil will then be enlarged to its utmost extent.

Another thing worthy our observation is, though the whole eye is encompassed with a membrane or skin which is not transparent, therefore will not admit the rays of light to pass through it, yet that directly over the pupil or hole of the eye (and only there) is a most delicate bright and exceeding transparent membrane, beyond the clearest glass, in order to afford a free passage for the light to penetrate to the cavity of the eye, which is blackned or coated with a dark tegument, that the rays of light may be there absorbed and suppressed, and not reflected back to confound the sight.

That none of the humours of the eye are tinged with any colour is remarkable, and this, however insignificant it may appear, is a very wise precaution; for had the humours of the eye been tinged with any colour, every object looked at would appear of

the same cast; as we find, that whatever is looked at through a coloured glass, appears of the same colour as the glass itself; and to those whose eyes are tinged with the jaundice, all objects appear of a yellow hue. Besides these, it is proved by experience, that a coloured body is not fit to admit the rays of light; therefore, had the humours of the eye been of any colour, many of the rays of light that proceed from the object looked at, would have been stopped before they could reach the retina or bottom of the eye, where the image of the object must be formed. To preserve this spherical, or roundish figure of the eye, so necessary for our delight, there is provided another humour in it, which is called the vitreous or glassy humour; it is very clear and bright, much like the white of an egg, and is in greater plenty than either of the other humours; it is placed behind the crystalline humour, and fills the whole cavity or dark chamber of the eye; this it is that makes it of a spherical form, and ever preserves it so: it also serves to keep the crystalline humour always at a proper distance from the retina, which receives the images of all objects.

It is admirable to behold how very fine all the tunics or membranes of the eye are, and yet of so firm a texture as to be able to contain so many different humours, and to perform so many different actions, without scarce ever being injur'd by so constant use; and so careful has the Creator been, that his creatures should enjoy this excellent and useful sense, no animal hath less than two eyes, each of which singly can perform all the offices of sight, that, if one should by any accident be injured or lost, the other might supply its place; an advantage experienced by numbers to this day, for we find many have the misfortune to lose one, and yet notwithstanding being deprived of such a member, enjoy nearly the same benefit of sight as they before received from both.

There is another curious particular the wisest men cannot in the least account for, which is, that though the image of every object is actually pictured on the retina of each eye, whilst we have two, yet we do not see the object double, but just the same as if we were to look at it only with one eye: Let us shut either eye whilst we are looking at any object; we see it still the same with the other; let us open them both, it makes no difference. How there should be two pictures formed, and yet we be sensible only of one, is a matter too extensive in magnitude for us to understand! but it is a manifest sign of the infinite skill and exquisite art employed by him, who solely invented and constructed that beautiful organ of sense.

Having described the wonderful structure of the Eye, we shall next consider the admirable provision which is made for its guard and security: it is fenced with strong compact bones, lodged in a well made socket, where it is defended from the strokes of any flat body, and guarded with a nice-made cover; the eye-lids, which are well fitted for this purpose, are made of a thin and flexible but strong skin, by which means they the better wipe clean, and guard the eye: the edges are fortified with a soft cartilage, by which means they are not only enabled the better to do their office, but also to close and shut the quicker. Out of this cartilage grows a palisade of stiff hairs, of great use to warn the eye of approaching dangers, and to shut out too excessive light which would be very hurtful: it is remarkable that these hairs grow but to a certain length, and need no cutting as many other hairs of the body do; also that their points stand out of the way, and in the upper lid bend upwards, as they do downwards in the lower lid, whereby they are well adapted to their use. And because the outward coat of the eye ought to be pellucid, to transmit the light (which if they always stood open, would be ap

to grow dry, shrink, and lose their transparency,) therefore are the eyelids so contrived as often to wink, so that they may glaze and varnish them over with the moisture they contain, there being glandules on purpose to separate a humour for that use, and withal wipe off whatever may stick to them; and this they do with the greatest celerity, lest they should hinder the sight. There are many other curious particulars relative to the Eye, but as we have already exceeded the number of pages allotted for this subject, shall conclude with briefly observing, that if the eye had been flat instead of being spherical, it would not have received the image of any object bigger than itself; for by means of its sphericity or roundish figure, the Eye can receive the images of the greatest bodies, and almost a fourth part of the heavenly ones at one glance. O admirable artificer! O most kind and gracious God! let the tribute of our grateful hearts ascend to Thee.

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C H A P. III.

A S T R O N O M Y.

BEHOLD and consider the immense extent of the Heavens! let our imagination stretch over millions of miles, and millions more will yet remain undiscovered. Behold the Sun begin his course; see the Clouds, like floating curtains, are thrown back at his approach: with what refulgent majesty does he walk abroad! how transcendently bright is his countenance shedding day and inexhaustible light through the universe! Is there a scene, though finished by the most elaborate and costly refinements of human art, comparable to these illustrious solemn

nities of open sunshine? before these, all the studied pageantry of the theatre, the glittering æconomy of an assembly, or even the heightened ornaments of a royal palace, hide their diminished heads and shrink into nothing. What are all the realms of the world but a dungeon of darkness, without the beams of the Sun! without that grand enlivening principal, what were this earth but a lifeless mass! a rude lump of inactive matter! the trees could never break forth into leaves, nor the plants spring up into flowers: when that auspicious sovereign of the day unbars the gates of light, and lets forth the morn, then what a prospect opens! the heavens are paved with azure! a variety of the liveliest verdures array the plains! the flowers put on a glow of the richest colours! the whole creation stands forth, dressed in all the charms of beauty! the ravished eye looks round and wonders! We have perhaps beheld it a thousand times, and not once considered what an amazing body it is! a mass of fire, nine hundred thousand times bigger than the earth we tread upon; whose diameter, or breadth, from one side to the other, measures more than eight hundred thousand miles; its circumference above two millions five hundred and eighty-two thousand miles; and its solid contents, such as confound the imagination, and are almost beyond the power of numbers to express: this great body revolves round his own axis in about twenty-five days. How great is the Lord that made it with a word! and has continued for so many ages to supply it in such a manner, and that, notwithstanding the perpetual deluge of light and heat, which it sends forth every moment from all parts of it, it remains undiminished, and as strong and diffusive as at the first day.

But amazing as the consideration of such a stupendous body is, the Heavens shew forth still greater wonders; and as there are various opinions concerning the different Systems of the universe, we shall

take notice of the three principal ones, viz. the Ptolemaic, the Copernican, and the New System; of each which in their order.

Of the Ptolemaic.

In the Ptolemaic System, the Earth and Waters are supposed to be in the centre of the universe; next to which is the element of Air; next above that is the element of Fire; next to that the orb of Mercury, then that of Venus, then that of the Sun; and above the sun's orb, those of Mars, Jupiter, and Saturn; and above them all, the Firmament, or orb of the fixed Stars; then the crystalline orb; and lastly, the *Cælum Emypyreum*, or Heaven of Heavens. All these massy orbs, and vast bodies borne by them, are in this system, supposed to move round the terraqueous globe once in twenty-four hours; and besides that, in some other certain periodical times: for effecting of which motions, they were forced to contrive such circles as they called Eccentrics and Epicycles, crossing and interfering with one another.

Of the Copernican System.

The next system is the Pythagorean or Copernican, being invented as some imagine, by Pythagoras himself. This system (whoever was the inventor of it) Copernicus, a canon of Tourain, restored about the beginning of the fifteenth century, and was followed by many considerable men, Rheticus Kepler, Rotham, and many others. According to this System, the sun is supposed to be in the centre, and the Heavens and Earth to revolve round about him, according to their several periods: first Mercury in near eighty-eight days, then Venus in somewhat above two hundred and twenty-four days; then the Earth with its satellite the Moon in three hundred

ane sixty-five days and one fourth ; then Mars in about six hundred and eighty-seven days ; then Jupiter with his four moons in about four thousand three hundred and thirty-three days ; and lastly Saturn, in somewhat above ten thousand seven hundred and fifty-nine days, with his five or more moons revolving about him : and beyond or above all these is the Firmament, or the region of fixt stars, which are all supposed to be at equal distances from their centre the sun. And so far as this system relates to the motion of the Earth, and the Sun resting in the centre, all modern authors approve of, on these five following accounts.

First, Because it is far more agreeable to nature, which never goes a round-a-bout way, but always acts by the most compendious, easy and simple methods ; and in the Copernican way, that is performed by one, or a few easy revolutions, which, in the other way, is made the work of the whole heavens, and of many strange and unnatural orbs : Thus the diurnal motion is accounted for by one revolution of the earth, which all the whole heavens are called for, in the other way ; so far the periodical motions of the planets, their stations, retrogradations and direct motions, they are all accounted for by one easy single motion round the sun, for which in the Ptolemaic way, they are forced to invent diverse, strange, unnatural, interfering eccentrics and epicycles : an hypothesis so bungling and monstrous, as gave occasion to a certain king to say “ If he had been of God’s council when he made the heavens, he could have taught him how to have mended his work.”

Secondly, As the Copernican system is far more easy and agreeable to nature than the Ptolemaic system, so it is far more complete and answerable to the various phenomena of the planets ; several of which the Ptolemaic hypothesis either very awkwardly solves, or doth not at all come up to. We might

instance here in divers particulars relating to Venus and Mercury, as, why the Earth is never between them and the Sun, which the Ptolemaic system gives no tolerable account of, and but poor accounts of other of their phænomena; as also those of the Moon and the other planets. We might shew also how incoherent and improper the motions assigned to the heavenly bodies are in the Ptolemaic way, as, that the Moon should move round once in a month, the other planets in such and such periods as are assigned to them; the Firmament or fixt stars in twenty-five or twenty-six hundred years; the sphere beyond that in seventeen hundred years; and the tenth sphere in three thousand four hundred years; and the outermost of all, the Primum Mobile, which moves all the rest, in twenty-four hours; which are motions so unproportional, and disagreeable, that are sufficient to subvert the whole hypothesis: but it would be endless to enter into a detail of such incoherences and improprieties as the Ptolemaic System abounds with.

Thirdly, The prodigious and inconceivable rapidity assigned by the Ptolemaics to the heavens, is by the Copernican scheme taken off, and a far more easy and tolerable motion substituted in its room; for is it not a far more easy motion for the Earth to revolve round its own axis in twenty-four hours, than for so great a number of far more massy and far distant globes, to revolve round the earth in same space of time? if the maintainers of the Ptolemaic system do object against the motion of the earth, that it would make us dizzy, and shatter our globe to pieces, what a precipitant, how terrible a rapidity must that of the Heavens be! what a velocity must the Sun have to run its course at the distance of twenty-one or twenty-two semi-diameters of the Earth! what a velocity must that of the fixt Stars, especially that of the Primum Mobile be, at far greater distances than the Sun is!

Fourthly, It is an incontestible argument of the Sun being the centre of the planets about him, and not the Earth ; that their motions and distance respect the Sun and not the Earth. For with regard to the Sun, the primary planets have a very due motion, in proportion to their several distances ; that is, their motions round the Sun are in sesquuplicate proportion to their distances from him : but this proportion doth not hold at all with relation to the Earth. But as for the secondary planets round Saturn, Jupiter, and the Earth, it is very certain that they have the same respect to their primaries, as these primaries have to the Sun ; that is, “ the squares of their revolutions are as the cubes of their distances.” And as it is certain and visible, that the secondary planets respect their primaries as their centres, and move round them, so it is in some measure (one would think) no less certain, and beyond doubt, that all the primary planets, which have the self-same respect to, and motion, with regard to the Sun, as those secondaries have to their primaries ; that those primaries do move round him as their centre, and not about the Earth, to whom they have no such respect.

Fifthly, The last argument we shall alledge for our preference of the Copernican to the Ptolemaic System, is from the great parity and congruity, observable among all the works of the creation ; which have a manifest harmony and great agreement with one another.

Thus in our present case, it is manifest to our sight, that every globe we have any good views of, hath such like motions, as those are which we ascribe to the Earth. The Sun indeed being in the centre, is as it were fixt there, and hath no periodical motion ; but yet the other motion round its own axis, we can manifestly discern ; and as for all the planets which move round about the Sun, they have as far as 'tis possible for us to see them, such motions as those

we ascribe to the Earth; namely, a diurnal rotation round their own axis, and a periodical revolution round the Sun. And if this be manifest in the other Planets, what should hinder its being so in our own, why ours be singular? why not supposed to be moved as well as the rest, when it is very certain that either it hath those motions, or that the Heavens have such? and it is far more natural and easy for the Earth to perform them, than the Heavens, as hath been already made appear.

Thus having shewn how far more probable the Copernican System is than the Ptolemaic, so far as it relates to the motions of the Heavens and Earth, and the Sun being in the centre; we shall next, agreeable to the observations of the learned, describe the diameter, circumference, and revolutions of several of the Planetary Bodies, in order as they revolve round the Sun, according to their several periods, viz.

Mercury's diameter is above two thousand seven hundred and forty-eight miles, his circumference seven thousand seven hundred and twenty-four, surface sixty-two millions, circuit above two hundred and one million, and his distance from the Sun thirty-two millions of miles; he revolves round his own axis, but in what time is uncertain.

Venus's diameter is above seven thousand miles, circumference more than twenty-four thousand, surface one hundred and ninety-six millions of square miles, circuit above three hundred and seventy millions, and his distance from the Sun fifty-nine millions of miles; he revolves round his own axis in twenty-three hours.

The Earth's diameter is above seven thousand nine hundred miles, circumference twenty-five thousand, surface one hundred and ninety-nine millions, circuit five hundred millions, and distance from the Sun eighty-one millions of miles; revolves round its

own axis in twenty-four hours, and flies through the air at the rate of a million and a half of miles each day.

We shall first describe the usefulness of the silver Queen of Night, next its magnitude, &c.

Let the reader only reflect, that when the last beams of departing day tinges the fleecy clouds with glowing purple, with what majesty the Moon rises and adorns the chambers of the east, and throws a silver mantle over the verdant carpet of nature; her reflected rays, at the same time they delight the eye, and gild every thing with the most delicate shade, yet doth not disturb us with her heat and lustre. Consider how uncomfortable the nights had been, wrapped in total darkness, had not a gracious God hung this glorious lamp on high, to enliven the dismal gloom, and line with silver the raven-colour'd mantle of the night. What are all the decorations of human art, when compared to those glowing lamps that adorn the ample circuit of the skies? the most costly refinements ever invented by the wit of man, are nothing in comparison; "the grandeur of the former is as much above the latter, as thunder is louder than a whisper!" Contemplate and reflect on the glorious works of the Creation, so admirably contrived for the service and delight of man; and every noble heart must be fired with gratitude towards the great and good Creator of the universe. Next of the magnitude, &c. of the Moon.

Her diameter is above two thousand seven hundred and fifty miles, circumference six thousand eight hundred, surface one million four hundred thousand, circuit in breadth four hundred and eighty thousand miles, which she performs her monthly revolution in, and turns round herself in the same time; she is distance from the earth about two hundred and forty thousand miles.

The diameter of Mars is four thousand eight hundred and seventy-five miles, circumference thirteen thousand, surface sixty-two millions, circuit seven

hundred and seventy-three millions, and distance from the Sun one hundred and twenty-three millions of miles; he moves round his own axis in twenty-four hours and forty minutes.

Jupiter's diameter is one hundred and thirty thousand six hundred and fifty-three miles, circumference three hundred and ninety-two thousand, circuit in diameter eight hundred and ninety-five millions one hundred and thirty-four thousand, surface of his body twenty thousand millions of square miles, distance from the Sun four hundred and twenty-four millions of miles; he revolves round his own axis in nine hours and fifty-six minutes. He has four Moons moving round him, to augment his light; the first of which moves round him in one day eighteen hours and a half; the second in three days thirteen hours and a half; the third in seven days three hours and forty-five minutes; the fourth in sixteen days sixteen hours and a half.

Saturn's diameter is ninety-three thousand four hundred and fifty-one miles, circumference above two hundred and eighty thousand three hundred and fifty-three miles, diameter of his orbit one thousand six hundred and forty-one millions five hundred and twenty-six thousand three hundred and eighty-six miles, surface fourteen thousand millions, and distance from the Sun seven hundred and seventy-seven millions of miles; he revolves round his own axis, but in what time is uncertain. This orb has five moons attending him, the first of which moves round him in one day twenty-one hours, the second in two days seventeen hours, the third in four days twelve hours and a half, the fourth in fifteen days twenty-two hours, the fifth in seventy-nine days seven hours: now as we know our Moon moves round the Earth in twenty-seven days seven hours, and is of particular service to us, in affording us light by reflection during the Sun's absence, so these bodies or moons

moving round Jupiter and Saturn in the same constant and settled revolution, it seems natural to think they are intended for just the same purpose as our Moon; and that therefore there are inhabitants in those Planets which stand in need of a constant supply of light as much as we do.

That bodies though dark of themselves may appear as bodies of light by reflection is very plain; for instance, the Moon has no other light but what it receives from the Sun; and it is the reflection of that light only, back again, which makes the Moon appear to us as a body of light. For was the Moon a light orb, an Eclipse could never happen; as the cause of such a phaenomena is when this globe of Earth in its circuit round the Sun is coming between the Moon and the Sun, whereby the light is intercepted from falling on the Moon; consequently she must appear a dark body. In the same manner, what we call an eclipse of the Sun, is in reality, an eclipse of the Earth; for it is occasioned by the Moon's coming between the Sun and the Earth; and whenever this happens (the Moon being a dark body) it intercepts the rays of the Sun from falling on that part of the Earth which it covers, and consequently darkness overshadows it: though these two bodies eclipse each other, not so much as their shade approaches any other of the celestial bodies.

There is a particular benefit arises from the diurnal motion of the Earth; which is that by this means the said globe never lies torpid: if in one spot of it, men and animals lie buried in sleep, in other parts they all alive and in action. By the diurnal turning of the Earth about its axis, every part enjoys the comfortable light and heat of the Sun, and the grateful vicissitudes of day and night; but as to the order of the periods of those planets we have before mentioned, we may add the consideration of the different paths of their periodical and diurnal motions; that they lie not in a very different plane as quite a

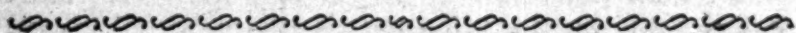
cross or the like ; nor exactly in the same plane, but a little crossing each other ; the diurnal course lying in, or parallel to the Equator, but the other in the broad path of the Zodiac, at an inclination of twenty-three one half degrees. What a glorious contrivance this is for the good of our globe, and doubtless no less so for all the rest that sympathize in the like motion ! For was the Earth's periodic motion to be always in the same plane with that of the diurnal, we might be sometimes be nearer to and sometimes farther from the Sun ; but at the same time miss of those kindly increases of day and night, together with such useful directions of the Sun's beams, which the advances of the Earth to one or other of the poles cause : which two things are the real causes of our seasons, summer, winter, spring and autumn, and not our being nearer to or farther from the Sun.

We shall conclude this subject with some very short observations on the New or third System, which extends the universe to a far more immense compass than either of the other, even to an indefinite space and replenishes it with a far more grand retinue than ever was before ascribed unto it.

It is the same with the Copernican, as to the Sun and its Planets ; but whereas the Copernican hypothesis supposeth the firmament of the fixt Stars to be the bounds of the Universe, and to be placed at equal distances from their centre the Sun ; this new system supposeth there are many other systems of suns and planets, besides that in which we have our residence, namely, that every fixt star is a sun, and encompassed with a system of planets, both primary and secondary, as well as ours. Mr. DERHAM is of opinion the New System is far the most rational and propable of any, for these reasons ; because it is the most magnificent of any, and worthy of an infinite Creator, whose power and wisdom, as they are without bounds and measure, so may in all probability exert themselves in the creation of many systems as well

as one ; for here we have the works of the creation, not confined to the more scanty limits of the orb, or arch of the fixt stars, or even the larger space of the Primum Mobile, which the ancients fancied were the utmost bounds of the universe, but they are extended to a larger as well as more probable, even an indefinite space. And as myriads of systems more particularly demonstrate the attributes of God than one, so it is no less probable than possible, there may be many besides this which we have the privilege of living in.

Think not what has been here asserted to be the chimeras of fancy only, for we have advanced nothing but what is built upon the nice calculations of Sir ISAAC NEWTON, and other accurate astronomers and mathematicians, taking the mean difference between their respective calculations.



C H A P. IV.

O R A T O R Y.

On the Advantage of Public Eloquence.

HOW great must that mind be which can conceive the express image of Eloquence ! For such a portrait aptly delineated, must present him with the queen of all things ; she rules the mind and sweetly sooths the heart.

The greatest geniuses ancient and modern have been profuse in their eulogiums on public eloquence. The fictions of poets have transmitted to us an Orpheus, who by the sweetness of his musical strains, could draw after him savage beasts, rocks, and other inanimate creatures. By this they would have us understand that it is in the power of eloquence to bring to the use of reason, men, even of rocky and

barbarous natures ; we may justly suppose the founders of cities could not have made an embodied people of a vagabond multitude, without the charms of persauasive words ; nor lawgivers, without the extraordinary talent of Speaking oblige men to bend their necks under the severity of their laws. We even are conscious to ourselves that the precepts of morality, tho' with deep vestiges impressed on our hearts by the author of nature, yet receive an additional beauty and inspire our minds with a more intense love of them, when illustrated by the ornaments of discourse. Certainly the gracious creator of our being has distinguished us in no respect more from other animals than by the gift of speech ; they surpass us in bulk, in strength, in the enduring of toils, in speed, and stand in less need of foreign helps ; guided by nature alone, they sooner learn to walk : but God, as a beneficent parent, has given us for our portions a gift far superior to any faculty the brutes enjoy, viz. the talent of Speech ; and as the Divine dispenser of all good things has not imparted to mankind a greater blessing, what can we esteem more deserving our labour and improvement ? what object is more worthy our ambition ?

Before we proceed to mention the advantages different States have reaped by the eloquence of their Councils, or the great losses they have sustained by being deprived of their orators, it is necessary to give some proper directions for the attaining a complete knowledge of Oratory.

Those whose business leads them to speak in public with a proper degree of elocution, ought to have a fund of good sense, a lively imagination, a faithful memory, an agreeable tone of voice, a correct pronunciation, a noble gesture, a becoming assurance, and a great faculty of speaking : the four last qualities may be acquired by the precepts of art and long exercise ; the other are the gifts of nature, which art may polish but cannot bestow. These talent

comprehend abundance of things yet do not compleat an Orator ; study and a thorough acquaintance with the learned and polite is necessary : before a man undertakes to speak in public, he should cultivate his judgment by reading the most celebrated authors, and particularly those that have written best in all sciences ; he should read the best books of his time, converse with men of the brightest genius, pay serious visits to ladies of wit, and make some small attempts in poetry in order to polish his manners and language.

If any one be so happy as to possess those advantages, he ought in the following manner to apply the precepts which Cicero, Quintilian, and others (of the best masters of Eloquence) have delivered. When the choice of the subject depends upon the orator, he ought to pitch upon one that is capable of force and ornament ; and strictly to preserve order in the design and connection in his thoughts : if possible, his discourse should never last longer than an hour ; the diction ought to be pure, and proper to the subject, rich and adorned without superfluity, strong and close without dryness, suitable to the person that speaks, to the place, to the time, and to the auditors. He cannot take too much care to avoid antiquated words ; the sublime and magnific style admits of nothing mean and low throughout the whole, not so much as a single sentence ; if any such thing be observed, it will lose its character : it consists in a most exquisite choice of words, polite and elegant, bold and ponderous ; great dignity of tropes and figures, which must appear to be used with freedom ; be splendid and noble, but not dazzling ; solemn majesty of sentences abounding with grand ideas and choice furniture of periods, numbers, &c. If any thing common occurs, it should be exalted by some trope, or beautified with a figure ; thus, instead of wine, fire, and bread, Bacchus cheers, Vesta warms, and Ceres satiates hunger. Let an Orator remem-

ber that it is to truth alone he ought to sacrifice the production of his wit ; he should courageously disengage himself from all interest that may oblige him to be guilty of flattery, and lay such a restraint upon the tongue as shall prevent satire and invective. Great care should be taken to surmount that foolish pride, which hinders many from following good advice ; he should guard against the insinuation of self-love, which is natural for us to shew to our own compositions : his narration ought to be exact, clear and concise, to run majestically like a great river and not with the rapidity of a torrent ; the elevation of his subject should consist in the greatness of things treated of, and not in the use of pompous words ; nothing must be advanced that will shock probability ; but he may be allowed the liberty of digressing from the subject, provided he does not lose sight of it ; but returns with more force and agreeableness : his comparisons ought to be just and short ; his metaphors all of a piece and natural ; quotations few and well chosen ; more seldom taken from a foreign than his native language, unless they cannot be translated with the same beauty, or carry more weight and authority in the tongue wherein they were first written : he ought to avoid all cold frivolous observations, proverbial or equivocal expressions, points and quibbles, as so many ill habitudes contracted from a sordid education, and ornaments unworthy of solid manly eloquence. It is requisite that the passions be moved, but then they are to be managed with great discretion, and mingled with great variety : in managing the voice great care must be taken, as the accents must be clear and articulate, every syllable standing off from that which is next to it, so that they might be numbered as they proceed : the inflections of the voice are to be so distinctly suited to the matter, that the humour or passion might be known by the sound of the voice only, where they could not be one word heard ; and the variations are to be like the full

swelling folds of the drapery in a fine picture or statue, bold, free, and forcible. True Eloquence does not wait for cool approbation ; like irresistible beauty, it transports, ravishes, and commands all within its reach ; the hearer finds himself as unable to resist it as to blow out a conflagration with the breath of his mouth, or stop the stream of a river with his hand ; his passions are no longer his own ; the orator has taken possession of them, and with superior power, works them to whatever he pleases.

There is no earthly object capable of making such various and forcible impressions upon the human mind as a consummate Speaker : in viewing the artificial creations which flow from the pencil of a Raphael, the critical eye is indeed delighted to a high pitch, and the delight is rational, because it flows from sources unknown to beings below the rational sphere ; but the ear remains unengaged and unentertained. It is only the elegant Speaker who can at once regale the eye with the view of its most amiable object, the human form, in all its glory ; the ear with the original of all music ; the understanding with its natural food, the knowledge of important truths ; and the imagination, with all that in nature or art, is beautiful, sublime, or wonderful : for the orator's field is the universe, and his subjects all that is known of God and his works. In a consummate Speaker, whatever there is of corporeal dignity or beauty, the majesty of the human face, the grace of action, the piercing glance, gentle languish, or fiery flash of the eye ; whatever of fine imagination, of wise reflection, or irresistible reasoning ; whatever is excellent in human nature, all that the hand of the Creator has impressed, of his own image, upon the noblest creature we are acquainted with, all this appears in the Orator to the highest advantage ; and whoever is proof against such a display of all that is noble in human nature, must have neither eye, ear, pas-

sion, imagination, taste, nor understanding. It is to be remembred, that the action, in expressing the various humours and passions, is to be suited to the age, sex, condition and circumstance of the character. Violent anger or rage is to be expressed with great agitation; but the rage of an infirm old man, of a woman, or a youth, are all different from one another, and from that of a man in the flower of his age, as every speaker's discretion will suggest: a hero may shew fear or sensibility of pain, but not in the same manner as a girl would express those sensations; grief may be expressed by a person reading a melancholy story, or description, in a room; it may be acted upon the stage, or dwelt upon by the pleader at the bar, and have a place in a sermon, the passion is still grief; but if they have judgment, the manner of expressing it will be different in each of these speakers. A correct Orator does not make a movement of limb or feature for which he has not a reason; if he addresses Heaven, he looks upwards; if he speaks to his fellow creatures, he looks round upon them; the spirit of what he says, or is said to him, appears in his look; if he expresses amazement, or would excite it, he lifts up his hands and eyes; if he invites to virtue and happiness, he spreads his arms, and his looks are all benevolence; if he threatens the vengeance of heaven against vice, he bends his eyebrows into wrath, and menaces with the arm and countenance: he does not needlessly saw the air with his arm, nor stab himself with his finger; he does not clap his right hand upon his breast, unless he has occasion to speak of himself; or to introduce conscience, or something sentimental; nor does he start back, unless he wants to express horror or aversion; he does not come forward but when he has occasion to solicit; he does not raise his voice but to express something peculiarly emphatical; he does not lower it, but to contract the raising of it. His eyes by turns according to the humour of the matter he has to ex-

press, sparkle fury, brighten into joy, glance disdain, melt into grief, frown disgust and hatred, languish love, or glare distraction. There is an error which is too inconsiderately received by many judicious persons, viz. that a public Speaker's shewing himself to be in earnest, will alone secure him of duly affecting his audience; were this true, the enthusiastic rant of the fanatic, who is often very much in earnest, ought to please the judicious; in whom, on the contrary, we know it only excites laughter or pity. It is granted that nature is the rule by which we are to speak, and to judge of propriety in speaking; and every Orator, who faithfully follows that universal guide, commands attention and approbation: but if he either thro' incurable natural deficiency, or by deviating into some incorrigible absurdity of manners, expresses the real and warm sentiments of his heart in such an awkward way, as shall effectually defeat his whole design upon those who hear him, and render himself the object of their ridicule; he may then retire from the rostrum, sufficiently convinced of his want of qualifications requisite to constitute an orator. Though it may be alledged that a great deal of gesture or action at the bar or in the pulpit, especially the latter, is not wanted, nor is quite in character, it is yet certain that there is no part of the man that has not its proper attitude: the eyes are not to be rolled along the ceiling as if the speaker thought himself in duty bound to take care how the flies behave themselves; nor are they to be constantly cast down upon the ground, as if he was before his judge receiving sentence of death; nor to be fixed upon one point as if he saw a ghost. The arms of the preacher are not to be needlessly thrown out as if he was drowning in the pulpit, or brandishing after the manner of the ancient Pugiles, or boxers, exercising themselves by fighting with their own shadows, to prepare them for the olympic contests; nor on the contrary, are they to be pocketed up, his arms to

hang by his sides as lank as if they were both withered. The head is not to stand fixed, as if the speaker had a perpetual creak in his neck; nor is it to nod at every third word as if he was acting Jupiter. Lastly, a judicious Speaker is master of such a variety of decent and natural motion, and has such command of attitude, that he will not be long enough in one posture to offend the eye of the spectator.

We shall conclude this subject with briefly remarking the many advantages community have enjoyed, by having men of elocution in the senates.

Should we pass in review the histories of remote ages, it will appear that the splendor and welfare of most states and commonwealths were chiefly owing to the force of eloquent counsels. Athens, the pride of Greece, the great nursery of arts and sciences, never decayed in power, never lost its liberty, till deprived of its orators. Nothing was so advantageous to the Roman republic or heightened so much its glory, as the encouragement given to oratorical talents, and the laudable exercise of the same noble faculties: hence so many speeches and harrangues in the assemblies of the people and in the senate; which were efficacious to obtain what could not be extorted by the injunctions of public edicts. In like manner, Generals of armies as often as they were to give battle, as often as sedition and mutiny alienated the soldiery; so they were wont by powerful eloquence, either to invigorate their hearts with manly courage, or recal them to a sense of their duty.

The true cause of the great credit of the civilians under the Roman emperors, may not improperly be attributed to the abject slavery they insensibly led the subject into; while Rome preserv'd her liberty, no great account was made of the civilians, the orators held the first rank in that city, as well as at Athens; and this is the reason why the Greek and Roman eloquence was so highly esteemed and applauded. Augustus, an able politician, perceived the danger he

was in from the orators ; he well knew, that whoever has a genius for a noble eloquence is bold, active, and a great enemy to slavery ; in order therefore to bring down the orators, he set the civilians against them, and ordered the judges to submit to their decisions ; who till then had no further authority than the possibility of persuading the judges. It is plain that when Augustus raised the civilians, he depended upon their compliance wherein he was not mistaken ; for they explained the laws in his favour, and made it their business to justify his unjust tho' mild usurpation. They found a way to re-unite in his person the most important dignities ; and when they had by degrees accustom'd the Romans to make application to him alone, and had rendered him master of a people who had conquered the world ; they made him master of the laws, by virtue of this famous maxim which they took care to inculcate, That what pleases the prince stands for a law. By this means they ascribed an absolute royal power to Augustus : the following emperors imitated that prince ; Vespasian raised the civilians to the highest degree of authority, and compleated the destruction of liberty and eloquence : from the time of Augustus his successors got such an ascendancy over the people, that the mysteries of the cabinet were studied, which contained that absurd doctrine, of the interest of the prince ; as it is separate from the interest of the state, and generally runs counter to the public good, judgment, capacity, and secrecy, where changed into craft, artifice, and dissimulation. Good and ill actions were no longer known by themselves ; every thing was interpreted according to the nice intention of the prince, or was judged by the curiousness of some malicious speculation. Complaints, which in all ages of the world have been allowed to the unfortunate ; tears, those natural expressions of our grief, and sighs, which slip from us in spite of our will ; nay bare looks at last became fatal. The least endeavour

to use the persuasive force of eloquence was thought the highest pitch of arrogance; even the simplicity of discourse was fancied to cover ill designs, and the discretion of silence to conceal mischievous intentions. To speak, to be silent, to rejoice, to be afflicted, to be fearful, or undaunted; all was criminal, and very often incurred the most rigorous punishment. Thus it was this noble people, from tasting the sweets of the best regulated liberty, which had its sources in, and was nurtured by nervous Eloquence, fell into the snares of the worst of tyranny and oppression; and such likewise are the calamities that must wait all other nations, when they prize more the sinister arts of life, than the beauty of order and integrity; the natural result of free and uncontrouled eloquent counsels.

C H A P. V.

M O R A L I T Y.

MORALITY is of so large an extent, and the practice of it admits of so many degrees of perfection, that we cannot at once acquire a due conformity to all its various prescriptions. The attainments of Virtue must be gradual, must be the result of repeated thought, and of repeated efforts. It must therefore be of great importance to set out in the moral course, upon such principles as will give the amplest scope for perpetual improvement, and be most favourable to our progress in every real excellence. Virtue consists in good affections; this must undoubtedly be understood not of transient or temporary emotions, but of such dispositions as are habitually prevalent in the soul. A single act of virtue, or the most casual exercise of any good action,

though it be not attended with steadiness and constancy, claims the approbation of every spectator; but to denominate us truly virtuous, it is necessary that our inclination to whatever is right and good, should be fixed and permanent, and that it should uniformly influence every part of our conduct. It is however evident, that though we cannot immediately arrive at any considerable degree of perfection in the practice of morality, yet the first hearty and deliberate resolution that we form, to endeavour to discharge the whole of our duty, so far as we can discover it, gives us a title to the virtuous character, as the forming such a general resolution is all that possibly can be done at once. If this resolution has not taken place in our minds, occasional acts of duty, ever so often repeated, will be of little moment in a moral estimate; and after we have once solemnly formed this purpose, nothing but our wilful neglect to put it in practice, can prevent us from making continual advances in every species of virtue and goodness: our first step then must be to consider, whether or no it is expedient that we should resolve invariably to submit to all the laws of morality? Let us now therefore take a view of some of those arguments which must be sufficient to lead us to such a resolution, if we will but attend to them with any degree of seriousness: and here let us suppose some person who has hitherto had no regard to the duties of life, nor perhaps ever admitted any kind of serious thought, suppose such a person by some means or other, awakened to a sense of the propriety of enquiring into the natural tendency of his own actions, and willing to learn the best and most advantageous manner of regulating his conduct in future time; the result of his enquiries, must undoubtedly be a full determination to endeavour to become as virtuous as possible; such a person must be sensible, that as yet he has lived to but little purpose. It is commonly asserted, that there is no real happiness

to be derived from any source, but the practice of our duty. Many of the advocates for religion and morality assert farther, that all, who are not habitually virtuous, must be inwardly wretched and miserable; but we will not go so far at present. There is undoubtedly much truth in these assertions; but these, as well as all other positions, may admit of some exceptions; we will therefore allow it possible, that some of those, who are wholly unmindful of their duty, may scarce ever feel themselves unhappy on that account. There are so many different ways of suppressing serious thought, and our present state affords such a variety of animal gratifications, that a person who enjoys a large flow of spirits, especially if possessed of wealth and affluence, may for many years escape those inward uneasinesses, which are the usual consequences of neglecting our duty: this however depends upon a prodigious number of concurring circumstances; it is every moment possible that some unexpected event may take place, which will force him to view things in a very different light from any in which they have ever before appeared to him. Bodily pain, the disappointment of some favourite scheme, a thousand incidents too minute to be thought of, or too sudden to be guarded against, may render all his former pleasures insipid, and plunge him in endless dissatisfaction and restlessness. It is certain, that all who are guilty of gross and flagrant vices, must be habitually subject to miserable anxieties, self-disgust, and heart-felt distress. They who are only guilty of neglecting their duty, can never be secure of any real satisfaction; as soon as ever they take a just review of their own conduct, and form an impartial estimate of their real state, they must perceive that they have acted an unworthy part in life; and that at present they are not capable of any thing that deserves the name of happiness; and let the course of their lives be ever so prosperous, let them have enjoyed every satisfaction which it is

possible for them to enjoy without virtue, when the hour of death approaches, if they are capable of reflection, they must feel, and own, that all their pursuits have been vanity, that they ought to have secured some nobler enjoyments; and that a life to be spent over again in the same insignificant and trifling manner, would be an object unworthy of a single wish. If these will be our sentiments at the conclusion of life, it cannot surely be impertinent to inculcate them upon those, who may apprehend such a period at the greatest distance. The earliest part of life cannot be too early to anticipate the ideas and sentiments which we shall form at its close; when we shall certainly see things in a much juster light than we do at present: can we be wise too soon? what a pity is it, that we should spend but half a life in such a manner as will yield us no satisfaction at death! what a folly to spend any part of our time in such a course as will heighten our distress at the trying hour!

If the person we now suppose to be deliberating about his future conduct, has launched out into any of the more enormous vices, he must already have felt in some measure the sad and deplorable consequences of immorality; for there is in fact, scarce any vice that does not involve those who practice it in some considerable inconveniencies: if he has only been regardless of the duties he ought to have performed, he must at least be sensible that he has never yet enjoyed any satisfaction equal to what his mind prompts him to desire, and hope for; it must therefore be worth his while to try whether or no he cannot attain those superior satisfactions, by entering upon the virtuous course. It cannot surely be out of his power some way or other, to attain to the gratifications of his highest desires; and what method can he now try, but that of virtue? Whether our enquirer chooses to be determined by the general experience of mankind, or by the natural consequences of human actions, either of these ways of judging must equally lead him

to forsake his vices, and to resolve upon virtue. The universal experience of mankind bears witness to this great truth, That the virtuous alone are possessed of the great art of enjoying life; and reason tells us, that every vice must necessarily hurt us either in our fortune, our health, our reputation, or the peace of our minds.

Should this enquirer farther proceed to take a view of every particular virtue and vice, he could need no argument to convince him, that every kind of virtue is infinitely amiable, and highly advantageous, and every vice worthy of his abhorrence, and necessary to be avoided, if he has any regard to his own welfare: but we suppose him now only endeavouring to form some general standard for the regulation of his future conduct; and this view must determine him to submit to all the laws of Morality without exception. That different kinds of conduct must be attended with different consequences, is an indisputable truth. That it is possible for us to do something that may tend to secure and heighten the comfort of our lives, is likewise a point not to be doubted: It is indeed no less than madness to hope for complete happiness in such a state as this. The best and wisest of men have their uneasiness here, but if the votaries of wisdom are too often unhappy, how much less can the slaves of folly ever enjoy any real felicity! Two things are evidently necessary to our passing through life with any degree of satisfaction; our passions and desires must all of them be subject to the dictates of reason, and regulated in such a manner as not to clash with one another; and our conduct must be steady and uniform. If we have various passions and desires, we must always be in a state of war and commotion; if we have only one predominant passion it will grow insatiable, and render happiness unattainable. If our conduct be not steady and consistent, we shall defeat our own views

in life, and can never approve ourselves; and without self-approbation any real satisfaction is a mere chimera. Let it also be remembred, that an inflexible steadiness, in any kind of vice, only renders a character the more detestable and the more pernicious; it must therefore be only a virtuous steadiness that can be the proper object of our pursuit; this alone can fit us for every state of life; this will support us under every possible affliction. But if we have indulged ourselves in vice, how will the recollection of our follies augment and aggravate every trouble in which we may be involved! Whatever is conducive to our happiness, upon the whole, must certainly be a part of our duty: nor do the laws of morality require any thing but what actually contributes to our welfare, and what therefore can be so absurd as to neglect them? If we wish to recommend ourselves to our fellow creatures, in what way can we do it so effectually, as by a steady and faithful discharge of every part of our duty? But our chief happiness certainly consists in the inward feelings of our own minds; and this consideration must be absolutely decisive in favour of virtue. That principle of conscience, which is implanted in every human breast, is capable of rendering the vicious miserable by its reproaches in the most prosperous state that we possibly can be with respect to worldly affairs; it can also render the virtuous happy by its approbation of their conduct, amidst the severest trials and afflictions. If therefore the virtuous only can enjoy the applause of their own consciences, this inestimable satisfaction must be a sufficient compensation for all the worldly inconveniencies we can ever draw upon ourselves by the practice of our duty.

But farther still, though the person we suppose to be engaged in this moral enquiry, should not have been used to reflect upon the existence and perfections of a God, it is however to be presumed, that at this season of calm reflection, he will be capable of dis-

cerning the evidences which nature and reason afford of an eternal, invisible, and all-perfect Being; whose power was the first cause of all things, and by whose providence the whole world is continually governed. Hence must arise a new set of motives for the choice of virtue: for if there is really such a Being at the head of the universe, it is apparent that he must have a peculiar regard for the virtuous; and that he will order all things in such a manner, as shall be most for their advantage. The light of nature encourages us to trust, that if we endeavour to discharge the whole of our duty, we shall not want any of those temporal blessings that may be upon the whole expedient for us: nay the light of nature leads us farther to expect some future state of existence, where the virtuous shall be highly rewarded, and the vicious receive a just punishment. Revelation amply confirms these suggestions of nature; and thus under the moral government of God, there is no one real advantage, which we may not justly hope for, if we regulate our conduct agreeable to the laws of morality; while on the other hand, such fatal consequences are annexed to the indulgence of vicious dispositions, as ought to make us tremble, so long as we continue unreformed.

We insist principally upon those arguments, which prove Virtue to be our interest, because these are the arguments which have the strongest and the most universal influence upon the human mind; but at the same time that any person is calmly enquiring what course of action must be most conducive to his interest upon the whole, all his natural sentiments of morality must undoubtedly concur to fix his choice aright. Our reason must on every occasion resent the indignity of being reduced to a state of subjection to irregular and disorderly passions. Our reason must give its sanction to every particular species of virtue. Nor shall we in this deliberate enquiry be able to re-

ject the arguments in support of our duty, without feeling that we commit an act of violence against the best and noblest part of our nature.

All these considerations being fairly put together, virtue appearing to be productive not only of inward peace, tranquillity, and joy, but likewise of all those external blessings which are really expedient for us, satisfying all the reasonable desires of our nature, raising us to the highest dignity of character here, and preparing us for still more exalted perfection and bliss in a future state; and vice being in every respect the direct reverse, what can be the result of the whole, but that every one, who is desirous of making a right choice, must resolve to discard every principle, and every pursuit that is inconsistent with virtue, to omit no opportunity of performing any act of duty, to improve every hour to the most valuable purposes, and to use his best diligence to attain every possible degree of moral rectitude and goodness? As soon as we are convinced that this is a rational system, we should admit of no delays: we ought immediately to impress it upon our minds; and in forming this resolution, we should use every circumstance of solemnity that may increase our sense of its importance, and perpetuate its influence upon our future conduct. From hence we are to date our commencement in the glorious course of Virtue and Goodness; and after we have once entered into such an engagement with ourselves, we must often recal it to our thoughts; in fact we must never suffer any thing to exclude it from our minds, for if it were not necessary for us always to retain this resolution, it could not be possible for us to form such a resolution at all.

When we first enter upon the virtuous course, we find the performance of some part of our duty may be attended with some difficulties, and we may sometimes be inclined to imagine, that we might obtain some advantages by actions that are contrary to our

duty ; but after we have decided the grand point, that virtue is, upon the whole, conducive to our chief and highest interest, we should not permit any prospects of temporary pleasure or advantage to retard the prosecution of our virtuous purposes ; and we must always remember, that by perseverance, the most difficult duties will become easy ; for it is not the difficulty of performing any part thereof, that so unhappily enfeebles our efforts towards the attaining of the more sublime and exalted degrees of virtue and goodness ; it is our own irresolution that unman, that fetters, and betrays us : it is the weakness of our attachments to whatever is good, that puts it in the power of any temptations to triumph over us, or in any degree to obstruct our progress towards perfection. No duty can be difficult, when we are once fully determined to perform it ; as soon as the resolution is completely made, the execution of it must be easy, and not only so, but delightful ; and who can fully conceive what glorious attainments we might make in every thing that is truly excellent, were our resolutions habitually strong enough to preserve us in the uniform and steady pursuit of moral perfection ? Let us then be honest to ourselves, and unless we can fully confute the arguments in favour of Virtue, let nothing prevent our strict adherence to that noble principle of conscience.

The great point being once determined, that we will steadily and uniformly persevere in such a course of action as we shall find to be most fit and reasonable, and conducive to the best and most important purposes ; we must proceed as soon as possible, to such further enquiries as may enable us to form a just standard of conduct for every part of life. In this search, our first attention must be due to the constitution of our own nature : Virtue has justly been defined as consisting in a conformity of temper and conduct to the general nature and fitness of things ;

but though there must undoubtedly be some general rule of conduct suitable to every different species of rational beings, yet with respect to each particular species, the fitness or unfitness of any action must have a more especial reference to their particular nature and constitution. Whatever is upon the whole, agreeable to the frame of our nature, must upon that account be incumbent upon us, though there may be other and more general considerations to enforce the same duty. We cannot doubt that every particular species of rational beings is well constituted by God : we are certain at least, that we are well adapted to the purposes of rectitude and virtue. It is evident, that whatever is contrary to the dictates of our nature, must be equally repugnant to every kind of real excellence and perfection ; and it is impossible that any being should be happy, in any way that is not perfectly agreeable to the original bent and tendency of his nature. Our moral enquirer must therefore find it well worth his while to examine himself as minutely as possible ; and in this enquiry let us now attend him.

The first particular that will engage his notice is, that Man is a being capable of many kinds of pleasure and pain, the prevalence of which must make him either happy or miserable : from hence it follows, that that course of action must be his duty, which will procure him the most numerous and the greatest pleasures, and guard him most effectually from uneasiness and pain.

But man is so constituted, that his happiness is very often as much affected by his expectations, with respect to what is to come, as by any thing that he actually enjoys or suffers at present. Our present portion, whether good or evil, soon becomes familiar to us ; nor is there any one circumstance in life, which can long occupy our attention, so far as to prevent us from seeking after something farther. We cannot help desiring whatever we imagine will prove an

advantage to us; and we are anxious to avoid any thing that threatens us with pain and trouble. To this purpose, various passions are deeply implanted in our nature, exciting us vigorously to pursue such objects as will be conducive to our welfare and pleasure, and to fly from every thing that would hurt or distress us; and with respect to those things which are not the object of any natural passion, we soon conceive an inclination or aversion to them, according to the light in which we view them, as advantageous or the contrary. It is evidently our duty to gratify such of our passions, as shall be consistent with our happiness upon the whole; and as to those things to which we have no original and constitutional inclination or aversion, we ought to inform ourselves thoroughly whether they tend to promote our eternal welfare, or to occasion us pain, and then to pursue or avoid them in such a manner, as is suitable to our natural desire of obtaining every possible good, and escaping every real evil.

We shall not particularly take notice of the several passions which relate only to the concerns of animal life: we shall only observe in general, that as Virtue implies a due regularity and mutual subordination of all our inclinations and desires, it must necessarily be the most certain method of procuring the completest gratification of each of them, as far as is really expedient; but those desires of the human mind, which spring from or are naturally connected with its moral feelings, must undoubtedly deserve a very considerable degree of attention.

There is however a far superior principle in our frame, the faculty of Reason: by this faculty, which is evidently the chief glory of our nature, we are closely allied to the most exalted rank of beings, even to those who are entirely free from the influence of passions. By this faculty, we are enabled to form some judgment upon every object, and upon

every idea that can present itself to our minds ; and the decisions of reason are invariably just, as far as it is acquainted with the several circumstances of the cases to be determined : our reason, if rightly exercised, will enable us to trace out the various consequences of actions, to discern the propriety or impropriety of any kind of temper and behaviour, and to form ourselves a regular and consistent system of conduct for every possible occurrence of life ; nothing therefore can be more evident, than that this principle ought continually to govern within us. It is only at particular seasons that our passions can justly be indulged ; but it must always be expedient and necessary to submit to the commands of reason. It is reason alone that can justly determine when, and in what degree any of our passions ought to be indulged. It is reason alone that can prevent our passions from becoming excessive, and secure us from contracting dangerous inclinations towards unsuitable objects. The right use of our reason will render every emotion of hope or fear, of joy or sorrow, and of desire and disgust, advantageous to us upon the whole : but if reason does not predominate within us, the practice of virtue, or the enjoyment of happiness must be wholly out of our power.

The importance of Virtue, and the fatal consequences of Vice, would be apparent from the deduction of reason ; but to excite us the more powerfully to the discharge of our duty, our constitution is furnished with strong propensities to goodness, till it is corrupted by evil examples and the indulgence of vicious habits. An affection to every thing that is agreeable to reason, may justly be supposed natural to every rational mind ; but as the deductions of reason are in some cases extremely slow, and the mind of man liable to be misled by false views of things, we have the additional principles of Moral Sense and of Conscience, and an ardent desire of attaining the completest degrees of every kind of real

excellence. These principles lead us to the perception of some duties which reason alone might not so easily have discovered, and affords us new motives to the practice of every thing which reason prescribes. The moral sense convinces us of the beauty of virtue, and engages us to the love and practice of it, as being in its own nature supremely amiable; conscience, with peculiar energy, applies the general truths of morality to every case in which we are more immediately concerned, urges us incessantly to perform whatever we perceive to be right and fit, makes us happy by its applause whenever we have acted well, and condemns us immediately when we neglect our duty.

Our natural affection to every thing that is truly great and excellent, must prove a strong incentive to the acquisition of every kind of virtuous perfection. It is true indeed, that this principle sometimes takes a false turn and degenerates into a wild ambition, a desire of being distinguished by such attainments as are either of no considerable importance, or of an evil and pernicious nature; but true greatness, and true goodness, are in reality, inseparable; and though the human mind naturally aspires to every thing which can be considered as a mark of distinction, the excellencies of virtue must undoubtedly appear to every one, who reflects at all, superior to every other excellence or distinction that can possibly be conceived: even the most vicious must at times be sensible that virtuous attainments are the highest and most distinguishing honours of which our nature is capable; we must therefore not only bid defiance, but we must also eradicate from our minds the moral sense, conscience, and every just and natural principle of ambition, before we can be in any degree comfortable and easy in the neglect of our duty.

There is likewise in the human mind a natural love of truth, and a strong desire of increasing in knowledge: we cannot but wish to be acquainted with truths of every kind; but the discoveries of those, which more immediately relate to our moral conduct, afford us peculiar satisfaction and delight: and as the faculty of reason amply qualifies us for the investigation of truth, our thirst for knowledge must in general tend to incline us to our duty. An enlightened mind cannot fail to discern the excellency and importance of morality; and nothing but absolute ignorance and stupidity, or a wilful inattention to truth, can render us indifferent to the glorious pursuits and attainments of genuine virtue.

It is evident that Man is a being of an active nature; that his powers of action are many and various, and that he never can be happy in a state of indolence. Each of our active powers, whether bodily or mental, frequently stands in need of relaxation; but when we cease to exert any one power, we necessarily recur to the exercise of some other power or faculty, as the only way in which we can have any real enjoyment. There are few persons who can long support a vacation from bodily exercise; but life becomes an intolerable burden, when we find ourselves equally incapable of bodily labour, and of mental application. Some indeed seem to have found out an art of trifling, by which they pass through life without any serious application, without any real business, and yet at the same time perfectly free from inward uneasiness and chagrin. But the truth of the case is, that such persons either apply themselves to mere trifles with all that earnestness, which is due to the most important concerns, or else their appearance of ease is wholly counterfeit. There is not a greater contraction in nature, than to suppose a man can be happy whilst he has no object that he judges worthy of his attention; and if his attention be engaged, it will doubtless excite his active powers. To

be indifferent towards all kinds of objects, is indeed the fault but of few : most persons are much rather chargeable with the opposite extreme, of being too keen in their desires, and too eager in their pursuits, though the objects they have in view be of ever so little importance. Hence we see so much agitation and bustle among those, who have scarce ever formed one serious and rational purpose in life ; whereas half the application and pains they bestow upon the most insignificant trifles, would be sufficient, if rightly directed, to conduct them to the highest happiness they could possibly attain. But though an habitual application to our duty would preserve us from much unnecessary labour and fatigue about trifles, it must however require constant attention and unwearied diligence, and will afford us numerous opportunities of exerting all our powers to the greatest advantage : nor is it possible we should exercise the best and noblest powers of our nature to real advantage but by the practice of virtue. Virtue alone can give full scope to our activity ; and that which is our highest interest ought to be prosecuted with the most vigorous efforts. If we would wish to make the activity of our nature advantageous to us, if we would not be active and laborious altogether in vain, we must be continually labouring to attain to every possible degree of virtuous perfection. But man is a free as well as an active being, and this one principal source of our happiness ; our will cannot be compelled ; we are always capable of exerting ourselves in what ever way we chuse. Freedom seems to be an inseparable companion of rational powers : for to what purpose could we be endowed with a capacity for deliberation, if we were not at liberty to chuse or refuse, in every case, as our will shall determine ? It has indeed been said, that Man is governed by his own opinion and sentiments ; and that they must necessarily be such as they actually are, being formed by a concurrence of circumstances entirely dependant on his own will.

and choice. But though the opinions we have entertained must necessarily influence the state of our minds, so long as they continue predominant within us, it is certainly at all times in our power to call in reason to our aid, to examine them calmly and impartially, and to correct our sentiments and reduce them to the standard of propriety. We may by this means convince ourselves, that what we once imagined to be our greatest infelicity, may in reality be most conducive to our welfare; and thus we may render ourselves happy in circumstances of the greatest difficulty. There is in fact, nothing so much under our power as our own opinions, and all other things, but our own opinions and conduct, are absolutely exempt from our power; but whilst we have these at command, we must certainly be free in the most important sense; and we cannot give a more convincing proof of our freedom, than in the choice of virtue, amidst the various difficulties to which it is often exposed; difficulties of such a nature, that though we may reasonably trust they will terminate to our advantage, yet nothing but an absolute freedom of choice could enable us to encounter them with resolution and cheerfulness. It is evident that every vicious principle tends to destroy our freedom; it limits and confines our choice, and insinuates that every thing which is inconsistent with its own gratifications to be unworthy our regard: but the virtuous principle is ever ready to submit to the closest examination; if then we would preserve our liberty, we must be virtuous.

Another leading principle in the frame of man, is his attachment to his fellow creatures. Exclusive of those connections which he enters into by the voluntary combination of public societies, he feels that he cannot be happy without a generous regard to their welfare. This natural feeling is manifestly conducive to our improvement in virtue, a principal part of which consists in endeavouring to be useful to all a-

round us ; and if we are desirous to contribute all in our power to the happiness of mankind, we must cultivate every virtuous disposition : for if we are deficient in any one of the several branches of virtue, it will in some degree lessen our abilities to serve those whom we would wish to assist and befriend. It is not necessary to our present purpose to enumerate the several ways in which our social affections must operate : let us only remember, that our natural relation to one another, should lead us to consult the welfare of all men, in every possible variety of circumstances, but especially of those who are most worthy ; and every action that proceeds from this principle, will afford us such exquisite pleasures, as will render it its own reward.

But as true piety must imply an ardent regard for our fellow creatures, for as a venerable writer justly argues, “ if we do not love our brother whom we have seen, how can we love God whom we have not seen ? ” in like manner genuine charity and benevolence towards mankind must imply purity of heart, or a rational moderation in all those desires and pursuits which relate immediately to our personal interests or pleasures ; for if our attention is wholly engrossed by our own concerns, we shall often be led into such a course of actions as must be absolutely inconsistent with every principle of benevolence towards others. Charity must always be productive of piety ; for if we are truly studious of the welfare of our fellow creatures, how can we fail to imbibe the warmest affection towards that Being, who is in his own nature the worthiest object of our love, as well as the original source of all the happiness that can ever take place in the universe ? if we consider virtue, as consisting in justice, this must naturally lead us to the discharge of every part of our duty, as being a debt of justice due unto God ; and it is also evident, that there is scarce any one act of morality, the neglect of which will not some way or other prove injurious to some of

our fellow creatures. Or again, if we consider virtue, according to the primary import of the word, as consisting in fortitude and strength of mind, what principles can be sufficient to enable us to acquire a steady fortitude in many circumstances of human life, exclusive of an humble submission to the will of God, and a disinterested attachment to the welfare of mankind.

Many cases will occur in which no general rule can be sufficient to guide us; there are some cases so intricate and perplexed, that after the utmost deliberation, we may be at a loss how to act; but if we should determine precipitately we may have endless cause to repent of our rashness; therefore serious consideration must be absolutely necessary; for if we admit a dissipation of thought, one unguarded moment may plunge us in such extreme irregularities of conduct, for which no future care or diligence can be able to atone. The continual changes of our circumstances in life must require new surveys and new resolutions, and the best principles may lead us into the most dangerous excesses, if we do not recollect ourselves, and consider to what degree they ought to be pursued, and in what instances they ought to be preferred to those of a very different kind. Piety may soon degenerate into foolish superstition, or wild enthusiasm; generosity may betray us into many weaknesses; the love of justice may render us savage and intractable; and fortitude may end in heroic madness.

It is possible that our social feelings may become too strong, and expose us to many inconveniencies; and for this reason, the love of independency is strongly imprinted upon our minds: every scheme of virtue that consists in retirement and a state of separation from mankind, is absurd and inconsistent; and every attempt to secure our happiness, by the neglect of those good offices which our fellow creatures justly claim from us, must render us incapable

of any solid satisfaction and self enjoyment; but whilst we are doing all in our power to promote the welfare of those around us, we must beware of any unworthy compliances with their capricious humours. Our nature forbids us to give way to immediate uneasiness, if, in some cases our endeavours fail of producing all the good we could wish; or if in others all our acts of kindness and friendship cannot procure us the the approbation and esteem of those whom we have laboured to please and serve. Our nature teaches us to be as useful as possible to others; but at the same time to live to ourselves; that is, to guard against every connection that might obstruct our progress in virtue, diminish our inward peace and comfort; or defeat any of the great purposes for which we were brought into being; and if in any case, mankind appear to be generally wrong, we must resolve to adhere to our duty, in opposition to every means they can use to dissuade or deter us from what is right

But though we may justly glory in our being thus independent upon man, we ought always to remember that we are in every possible sense dependent upon God; we have no one source of happiness but what we originally derive from him; to him we are indebted for all the powers of our nature; to his persevering providence, we owe the continuance of all our capacities and faculties; and his concurrence is necessary to the success of our best concerted schemes, and most vigorous efforts, for the attainment of happiness: in ourselves we are weak and indigent creatures, our wants are many; and he only can supply them: our frailties and imperfections are innumerable; and he only can enable us to attain to any thing that is truly valuable, great, and excellent. If his favour and blessing are thus essential to our well being, we ought certainly to cultivate a most humble sense of our constant dependence upon him; and if the disposal of every thing relative to us is en-

tirely in his hands; if all that we are and all that we have, are derived from him; if we have already received the most ample communications of his bounty, and are encouraged to hope for still further instances of his goodness, it must be incumbent upon us to endeavour to please him the whole course of our lives; it must be our duty to study his will, and to submit ourselves to him in all things: the perfections of his nature, and the manifest obligations he has conferred upon us, give him a right to our obedience; we must therefore be accountable to him for every part of our conduct; and of this he has given us sufficient intimations in the original structure of our minds; for it is apparent that all the various nations and tribes of mankind, of whom we have any knowledge, have a natural sense of God imprinted upon them; not only as their Almighty friend and protector, but also as their great Sovereign and Judge. And if he is our judge, it is evident that we cannot secure his approbation by any method, but the practice of Virtue, Righteousness, and Piety.

Let us just take notice of another particular in the human constitution, which, though little attended to by some, is however capable of affecting our happiness to a great degree. Man is naturally fond of variety and novelty; and what is there that can afford us such diversified pleasures as virtue can? the pursuits of vice are very nearly the same during the whole course of the longest life; and the pleasures of appetite can only be the same transient sensations repeated from time to time, and on every repetition less capable of affording us any considerable delight; but virtue expands the mind, enlarges all the powers of our nature, opens within us new avenues of joy, and, by increasing the extent of our activity, and adding a dignity to our characters, purposes and views, it leads us to such kinds and degrees of satisfaction and joy, as our imagination could not previously have conceived: and here it is also to be re-

marked, that in consequence of our love of variety, and the changeableness of our taste, we may soon be disgusted with any of the pleasures of vice; but if we continue virtuous, our relish for each of the joys that result from true goodness, must perpetually increase.

If man is fond of variety and change in his pleasures, he is necessarily subject to a vast variety of alterations and changes in his circumstances in life. When we are most at ease, we are every hour liable to the most sudden transitions from joy to sorrow, from health to sickness, and from affluence to want; and when we are under the pressures of affliction, a change for the better may instantly take place: this constant uncertainty and changeableness of our circumstances in life, is undoubtedly advantageous to us upon the whole; but to support these changes aright, it is necessary that good principles should be firmly established in our minds. Virtue alone can prepare us for every change, and enable us to preserve a noble steadiness and serenity amidst all the vicissitudes of life.

Of all the changes to which we are subject, that which closes our present scene of existence must demand our chief attention. Whatever our present condition may be, it will soon become totally different. Man is a short liv'd being, and cannot be certain of any more than the present moment: this is a solemn perpetual call to the most active diligence and zeal for the improvement of our time, for the acquisition of every virtuous excellence and perfection, and for the accomplishment of all our good designs as speedily as possible; and if we habitually exert ourselves to this purpose, we shall not have lived in vain, though our term of life be ever so short. In such a course we must have attained the best and most valuable enjoyments that this state can yield us; and the conscientiousness of having acted an useful and honourable part in life, must enable us to meet

death with fortitude and composure at least, if not with rapture and triumph: but how incapable of comfort must the vicious man be at the hour of death, even though he should have been uninterruptedly successful in life!

So long as we are continued in this state, we must be capable of a constant progress in every thing that is truly good and excellent; no attainments we may have already made, can put it out of our power to make a still further progress; our actual attainments must in fact enable us, and lay us under an obligation to be continually pressing on nearer and nearer to perfection: were we to live ever so many ages, we might still be improving in wisdom and goodness; but though the utmost attainments man can make in this life, are attended with such defects, as ought to keep him perpetually humble, yet he that does the best in his power, must necessarily make some considerable advances in true goodness, and consequently must be the object of God's approbation, and intitled to high esteem among mankind. But our consummation in perfection and bliss can only take place in a future state: our natural feelings lead us to expect some future existence; and Divine revelation assures us, that this life is only a state of probation, to fit us for a glorious immortality, where virtue will be crowned with unfading glory and felicity, and vice be overwhelmed with remediless confusion.

Here then let us make a solemn pause, and let every one give full scope to the suggestions of his own heart, upon such a subject as the expectations of a Blessed Immortality;—the nature of Man and the great purposes of his being, are an unbounded field for reflection; let us therefore strictly tread the sacred paths of Virtue, which is the only road to true and complete felicity.

C H A P. VI.

The PRINCIPLES of POLITENESS.

*With necessary Instructions to form a Man of Honour,
Taste, & Fashion.*

Absence of Mind.

AN absent man is very disagreeable in company; he is defective in all the common offices of civility; he does not enter into the general conversation, breaks into it from time to time with some starts of his own, as if he waked from a dream: he seems wrapped up in thought, and possibly does not think at all: he leaves his hat in one room and his stick in another; this is a sure indication, either of a mind so weak that it cannot bear above one object at a time; or so affected, that it would be supposed to be wholly ingrossed by some very great and important objects.

Sir ISAAC NEWTON, Mr. LOCKE, and perhaps five or six more since the creation, may have had a right to absence, from the intense thought their investigations required; but such liberties cannot be claimed by, nor will be tolerated in any other persons.

I had rather be in company with a dead man, than with an absent man; for if the dead man affords me no pleasure, at least he shews me no contempt; whereas the absent man very plainly though silently, tells me that he does not think me worth his attention: besides, an absent man can never make any observations upon the characters, customs, and manners of the company; he may be admitted into the best companies all his life time (if they will admit him) and never become the wiser.

Attention.

A man is fit for neither business nor pleasure, who either cannot or does not, command and direct his attention to the present object, and in some degree banish for that time, all others from his thoughts. If at a ball, a supper, or a party of pleasure, a man was to be solving in his own mind, a problem in Euclid, he would be a very bad companion, and make a poor figure in that company; or if, in studying a problem in his closet, he was to think of a minuet, we are apt to believe that he would make a very poor mathematician.

There is time for every thing, if you do but one thing at once; but there is not time sufficient in a year, if you do two things at a time.

A steady and undissipated attention to one object, is a sure mark of a superior genius; as hurry, bustle, and agitation, are the never failing symptoms of a weak and frivolous mind. You should not only have attention to every thing, but a quickness of attention, so as to observe, at once, all the people in the room; their motions, looks, and words; and yet without staring at them, and seeming to be an observer.

The most material knowledge of all, we mean the knowledge of the world, is never to be acquired without great attention; and we know many old people, who, though they have lived long in the world, are but children still as to the knowledge of it, from their levity and inattention. Certain forms which all people comply with, and certain arts which all people aim at, hide in some degree, the truth, and give general exterior resemblance to almost every body: attention and sagacity see through that veil, and discover the natural character: there are little attentions which are infinitely engaging, and which will secure us the esteem of mankind; as, for example, suppose you invited any body to dine or sup with you, you

ought to recollect if you had observed that they had any favourite dish, and take care to provide it for them; and when it came you should say, at such a place you gave this dish the preference, therefore I ordered it; this is the wine that I observed you liked, and therefore I procured some: most people have their aversions or their fondness for different things: remove from your friend what he dislikes, and procure for him what he likes, and that will convince him that he is an object worthy of attention, flatters his vanity, and perhaps makes him more your friend, than a more important service would have done him. Consult your own breast, and recollect how these little attentions, when shewn you by others, flatter that degree of self-love and vanity, from which no man living is free. Reflect how they incline and attract you to that person, and how you are propitiated afterwards to all which that person says or does; the same causes will have the same effect in your favour.

Aukwardness.

Now aukwardness can proceed but from two causes; either from not having kept good company, or from not having attended to it. When an aukward man comes into a room, he goes and places himself in the place of the whole company where he should not; there he soon lets his hat fall down, and taking it up again, throws down his stick, in recovering his stick his hat falls a second time; so that he is a quarter of an hour before he is in order again: if he drinks tea or coffee he certainly scalds his mouth and spills the tea or coffee on his breeches: at dinner, his aukwardness distinguishes itself particularly, as he has more to do: he holds his knife, fork, and spoon, differently from other people; eats with his knife to the great danger of his mouth,

picks his teeth with his fork, and puts his spoon, which has been in his throat twenty times, into the dish again : if he is to carve, he can never hit the joint ; but in his vain efforts to cut through the bone, scatters the sauce in every body's face. When he drinks, he infallibly coughs in his glass and besprinkles the company : besides all this, he has strange tricks and gestures ; such as snuffing up his nose, or blowing it and looking afterwards in his handkerchief, so as to make the company sick : his hands are troublesome to him when he has not something in them, and does not know where to put them ; but they are in perpetual motion between his bosom and his breeches : he does not wear his cloaths, and in short does nothing like other people. All this we own is not in any degree criminal ; but it is highly disagreeable and ridiculous in company, and ought most carefully to be avoided by whoever desires to please.

From this account of what you should not do, you may easily judge what you should do ; and a due attention to the manners of people of fashion, and who have seen the world, will make it habitual and familiar to you.

Bashfulness.

There is a very material difference between modesty and awkward bashfulness, which is as ridiculous as true modesty is commendable : it is as absurd to be a simpleton, as to be an impudent fellow ; and we may make ourselves contemptible, if we cannot come into a room and speak to people without being out of countenance, or without embarrassment. A man who is really diffident, timid, and bashful, be his merit what it will, never can push himself in the world ; his despondency throws him into inaction, and the forward, the bustling, and the petulant will always precede him : the manner makes the whole

difference; what would be impudence in one manner, is only a proper and decent assurance in another. A man of sense, and knowledge of the world, will assert his own rights, and pursue his own objects, as steadily and intrepidly as the most impudent man living, and commonly more so; but then he has art enough to give an outward air of modesty to all he does. He appears in company with a graceful and proper assurance, and is perfectly easy and unembarrassed: he is not dazzled by superior rank; he pays all the respect that is due to it, without being disconcerted; and can converse as easily with a king as a peasant. This is the great advantage of being introduced young into good company, and of conversing with our superiors: a well bred man will converse with his inferiors without insolence, and with his superiors with respect and ease. Add to this, that a man of genteel behaviour, though of inferior parts, is better received than a man of superior abilities, who is unacquainted with the world. Modesty, and a polite, easy assurance, should be united.

Company.

To keep good company, especially at our first setting out, is the way to receive good impressions. It consists not wholly of people of birth and rank; for people of neither birth nor rank are frequently and very justly admitted into it, if distinguished by any peculiar merit, or eminency in any liberal art or science. A company wholly composed of learned men, though greatly to be respected, is not meant by the words good company: they cannot have the easy and polished manners of the world, as they do not live in it: if we can bear our parts well in such a company, it will be proper to be in it sometimes, and we shall be more esteemed in other companies, for having a place in that. A company consisting wholly of professed wits and poets, is very inviting to young men

who are pleased with it, if they have wit themselves ; and if they have none, are foolishly proud of being one of it : but such companies should be frequented with moderation and judgment.

A wit is a very unpopular denomination, as it carries a terror along with it ; and people are as much afraid of a wit in company, as a woman is of a load-edging, which she supposes may go off of itself, and do her a mischief : their acquaintance, however, is worth seeking, and their company worth frequenting ; but not exclusively of others, nor to such a degree as to be considered only as one of that particular set. Be equally careful to avoid that low company, which in every sense of the word is low indeed ; low in parts, low in manner, and low in merit. Vanity, that source of many of our follies, and of some of our crimes, has sunk many a man into company in every light infinitely below him, for the sake of being the first man in it : there he dictates, is applauded, and admired ; but he soon disgraces and disqualifies himself for any better company. Let us imitate the real perfections of the good company into which we may get ; copy their politeness, their carriage, their address, and the easy and well bred turn of their conversation ; but we should remember, that, let them shine ever so bright, their vices, if they have any, are so many blemishes, which we would no more endeavour to imitate, than we would make artificial warts upon our faces, because some very handsome man had the misfortune to have a natural one upon his. We should, on the contrary, think how much handsomer he would have been without it.

Rules for Conversation.

When in company, inform yourself of the characters before you give way to what your imagination may prompt you to say. There are in all companies,

many who deserve than who like censure; should you therefore expatiate in the praise of some virtue, which some in company notoriously want; or declaim against any vice, which others are notoriously infected with; your reflections, however general and unapplied, will, by being applicable, be thought personal, and levelled at those people.

Tell stories but seldom, and absolutely never, but where they are very apt, and very short. Never hold any body by the button, in order to be heard out; for if people are not willing to hear you, you had much better hold your tongue than them. Long talkers generally single out some person in company to whisper to, this is excessive ill-bred, and in some degree, a fraud; conversation stock being a joint and common property. It is the height of ill-manners to interrupt any person while speaking, by speaking yourself, or calling off the attention of the company to any new subject. Take rather than give the subject of the company you are in: if you have parts, you will shew them, more or less, upon every subject, and if you have not, you had better talk filly upon a subject of other people's, than of your own choosing.

Never display your learning, but on particular occasions; reserve it for learned men, and let even these rather extort it from you, than appear forward to display it; hence you will be deemed modest, and reputed to have more knowledge than you really have. The man who affects to display his learning, will be frequently questioned; and if found superficial, will be ridiculed and despised; if otherwise, he will be deemed a pedant. Nothing can lessen real merit (which will always shew itself) in the opinion of the world, but an ostentatious display of it by its possessor.

Avoid polemical arguments as much as you can in mixed companies; but when you do oppose or contradict any person's assertion or opinion, let your

manner, your air, your terms, and your tone of voice be soft and gentle, and that easily and naturally, not affectedly. If your oponent be warm, endeavour to change the conversation, but first finish the argument or dispute with some little good-humoured pleasantry, to shew that you are neither hurt you self, nor meant to hurt your antagonist.

Upon all occasions avoid speaking of yourself, if it be possible. Some abruptly, speak advantageously of themselves, without either pretence or provocation: this is downright impudence. Others proceed more artfully, as they imagine; forging accusations against themselves, and complaining of calumnies which they never heard, in order to justify themselves, and exhibit a catalogue of their many virtues: "they acknowledge, indeed, it may appear odd, that they should thus talk of themselves, it is what they have a great aversion to, and what they could not have done, if they had not been thus abused." This thin veil of modesty drawn before vanity, is much too transparent to conceal it, even from those who have but a moderate share of penetration.

There are a thousand follies and extravagancies which vanity draws people into, and which always defeat their own purpose: the only method of avoiding these evils, is never to speak of ourselves; but when, in a narrative, we are obliged to mention ourselves, we should take care not to drop a single word that can directly, or indirectly, be construed as fishing for applause: be our characters what they will, they will be known; and no body will take them upon our own words! nothing that we can say ourselves will varnish our defects, or add lustre to our perfections; but, on the contrary, it will often make the former more glaring, and the latter obscure. If we are silent upon our own merits, neither envy, indignation, nor ridicule, will obstruct or allay the applause which we may really deserve; but if we are our own panegyrists upon any occasion, however art-

fully dressed or disguised, every one will conspire against us, and we shall be disappointed of the very end we aim at.

Take care never to seem dark and mysteriously, which is not only a very unamiable character, but a very suspicious one too: if you seem mysterious with others, they will be really so with you, and you will know nothing. The height of abilities is, to have a frank, open, and ingenuous exterior, with a prudent and reserved interior; to be upon your own guard, and yet, by a seeming natural openness, to put people off theirs. The majority of every company will avail themselves of every indiscreet and unguarded expression of yours, if they can turn it to their own advantage.

Always look people in the face when you speak to them; the not doing it is thought to imply conscious guilt; besides that, you loose the advantage of observing, by their countenances, what impression your discourse makes upon them. In order to know people's real sentiments, we should trust much more to our eyes than to our ears; for they can say whatever they have a mind we should hear; but they can seldom help looking what they have no intention we should know.

Private scandal should never be received nor retailed willingly; for though the defamation of others may, for the present gratify the malignity or the pride of our hearts, yet cool reflection will draw very disadvantageous conclusions from such a disposition: in scandal, as in robbery, the receiver is always thought as bad as the thief.

Never in conversation, attack whole bodies of any kind; for you may thereby unnecessarily make yourself a great number of enemies. There are good as well as bad of every sect and profession; all general reflections upon nations and societies, are the trite thread-bare jokes of those who set up for wit with-

out having any. Judge of individuals from your own knowledge of them, and not from their sex, profession, or denomination.

Mimicry, which is the common and favourite amusement of little, low minds, is in the utmost contempt with great ones: it is the lowest and most illiberal of all buffoonery: we should neither practice it, nor applaud it in others; besides that, the person mimicked is insulted; and an insult is not easily forgiven.

We may frequently hear some people in good company, interlard their conversation with oaths, by way of embellishment, as they suppose; but swearing without having a single temptation to plead, is as silly and as illiberal as it is wicked.

In conversation be explicit, for nothing makes a man look sillier in company, than a joke or pleasantry not relished, or not understood; and, if he meets with a profound silence when he expected a general applause; or what is still worse, if he is desired to explain a joke, his awkward and embarrassed situation is easier imagined than described.

Be careful how you repeat in one company what you hear in another. Things seemingly indifferent may, by circulation, have much graver consequences than may be imagined. There is a kind of general tacit trust in conversation, by which a man is engaged not to report any thing out of it, though he is not immediately enjoined secrecy. A retailer of this kind draws himself into a thousand scrapes and discussions, and is shily and indifferently received wherever he goes.

Always adapt your conversation to the people you are conversing with; for I suppose you would not talk upon the same subject, and in the same manner, to a bishop, a philosopher, a captain, and a woman.

A certain degree of exterior seriousness in looks and motions gives dignity, without excluding wit and

decent cheerfulness. A constant smirk upon the face, and a whiffing activity of the body, are a strong indication of futility.

Graces.

The graces of the person, the countenance, and the way of speaking, are essential things: the very same thing, said by a genteel person, in an engaging way, and gracefully and distinctly spoken, would please; which would shock if muttered out by an awkward figure, with a fullen, serious countenance. The poets represent Venus as attended by the three Graces, to imitate, that even beauty will not do without. Minerva ought to have three also; for without them, learning has few attractions.

If we examine ourselves seriously, why particular people please and engage us, more than others of equal merit; we shall always find that it is because the former have the graces, and the latter have not. We have known many a woman, with an exact shape, and a symmetrical assemblage of beautiful features, please very few; while others with very moderate shapes and features, have charmed every body. It is certain that Venus will not charm so much without her attendant graces, as they will do without her. Among men, how often has the most solid merit been neglected, unwelcome, or even rejected for want of them! while flimsy parts, little knowledge, and less merit, introduced by the graces, have been received, cherished and admired.

A man's fortune is frequently decided forever by his first address: if it is pleasing, people are hurried involuntarily into a persuasion, that he has a merit, which possibly he has not; on the other hand, if it is ungraceful, they are immediately prejudiced against him, and unwilling to allow him the merit, which, it may be, he has: the worst bred man in Europe,

should a lady drop her fan, would certainly take it up and give it to her; the best bred man could do no more; the difference, however, would be considerable, the latter would please by his graceful address in presenting it; the former would be laughed at for doing it awkwardly: the carriage of a gentleman should be genteel, and his motions graceful: he should be particularly careful of his manner and address, when he presents himself in company; let them be respectful without meanness, easy without too much familiarity, genteel without affectation, and insinuating without any seeming art or design. Men as well as women are much oftner led by their hearts than by their understandings: the way to the heart is through the senses; please their eyes and their ears, and the work is half done.

Dress is one of the various ingredients that contribute to the art of pleasing, and therefore an object of some attention; for we cannot help forming some opinion of a man's sense and character from his dress. All affectation in dress implies a flaw in the understanding: men of sense carefully avoid any particular character in their dress; they are accurately clean for their own sake, but all the rest is for the sake of other people.

The difference in dress between a man and a fop, is, that the fop values himself upon his dress; and the man of sense laughs at it, at the same time he knows he must not neglect it: there are a thousand foolish customs of this kind, which, as they are not criminal, must be complied with, and even cheerfully by men of sense. Diogenes, the cynic, was a wise man for despising them, but a fool for shewing it.

When we are once well dressed for the day, we should think no more of it afterwards; and without any stiffness for fear of discomposing it: we should be easy and natural as if we had no cloaths on at all.

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Dancing likewise, though a trifling thing, is one of those established follies which people of sense are sometimes obliged to conform to; and if they do, they should be able to perform it well.

Those who present themselves well, have a certain dignity in their air, which, without the least seeming mixture of pride, at once engages and is respected.

Many people have got a very disagreeable and silly trick of laughing when they speak; and many men of very good parts, who cannot say the commonest thing without laughing, which makes those, who do not know them, take them at first for natural fools.

It is of the utmost importance to write well; as this is a talent which daily occurs, as well in business as in pleasure; and inaccuracies in orthography, or in style, are never pardoned but in ladies; nor is it hardly pardonable in them. The epistles of Cicero are the most perfect models of good writing. Letters should be easy and natural, and convey to the persons to whom we send them, just what we would say to those persons if we were present with them.

Neatness in folding up, sealing, and directing letters, is by no means to be neglected. There is something in the exterior even of a letter, that may please or displease, and consequently deserves some attention.

Style is the dress of thoughts; and let them be ever so just, if your style is homely, coarse, and vulgar, they will appear to as much disadvantage, and be as ill received, as your person, though ever so well proportioned, would, if dressed in rags, dirt, and tatters: it is not every understanding that can judge of matter; but every ear can, and does judge more or less, of style.

Knowledge of the World.

We should endeavour to hoard up, while we are young, a great stock of knowledge; for though during that time of dissipation we may not have occasion to spend much of it, yet a time will come when we shall want it. The knowledge of the world is only to be acquired in the world, and not in the closet. Books alone will never teach it you; but they will suggest many things to your observation, which might otherwise escape you; and your own observations upon mankind, when compared with those you will find in books, will help you to fix the true point.

To know mankind well, requires full as much attention and application as to know books, and it may be, more sagacity and discernment. There are many elderly people who have passed their whole lives in the world, with such levity and inattention, that they know no more of it now than they did at fifteen: we ought not therefore to flatter ourselves with the thoughts that we can acquire this knowledge in the frivolous chit of idle companions: no, we must go deeper than that: we must look into people as well as at them. Search therefore with the greatest care, into the characters of all those whom you converse with; endeavour to discover their predominant passions, their prevailing weaknesses, their vanities, their follies, and their humours; with all the right and wrong, wise and silly springs of human actions, which make such inconsistent and whimsical beings of us rational creatures.

There are no persons so insignificant and inconsiderable, but may, sometime or other, and in something or other, have it in their power to be of use to you; which they certainly will not, if you have once shewn them contempt: wrongs are often forgiven, but contempt never is; our pride remembers.

it forever. Remember therefore, most carefully to conceal your contempt however just, wherever you would not make an implacable enemy. Men are much more unwilling to have their weaknesses and imperfections known, than their crimes; and if you hint to a man, that you think him silly and ignorant, or even ill bred or awkward, he will hate you more, and longer, than if you tell him plainly, that you think him a rogue.

If we have wit, we should use it to please and not to hurt: we may shine like the sun in the temperate zones, without scorching. If you find yourself subject to sudden starts of passion, resolve within yourself, at least, never to speak one word while you feel that emotion within you. In short, make yourself absolute master of your temper and countenance, so far at least, that no visible change do appear in either whatever you may feel inwardly: this may be difficult, but it is by no means impossible; as a man of sense never attempts impossibilities; on one hand, on the other, he is never discouraged by difficulties: on the contrary he redoubles his industry and his diligence, he perseveres, and infallibly prevails at last. In any point that prudence bids you pursue, and which a manifest utility attends, let difficulties only animate your industry, not deter you from the pursuit; if one way has failed, try another; be active, persevere, and you will conquer.

Study individuals, then; and if you take (as you ought to do) their outlines from their prevailing passion, suspend your last finishing strokes till you have attended to and discovered the operations of their inferior passions, appetites, and humours. A man's general character may be that of the honestest man in the world: do not dispute it, you may be thought envious or ill-natured: but at the same time do not take this probaty upon trust, to such a degree as to put your life, fortune, or reputation in his power.

This honest man may happen to be your rival in power, in interest or in love ; three passions that often put honesty to most severe trials, in which it is too often cast : but first analyze this honest man yourself ; and then only, you will be able to judge how far you may, or may not with safety trust him.

Suspect in general, those who remarkably affect any one virtue ; who raise above all others, and who in a manner, intimate that they possess it exclusively : suspect them ; for they are commonly impostors : but do not be sure that they are always so ; for we have known saints really religious, blusterers really brave, reformers of manners really honest, and prudes really chaste. Pry into the recesses of their hearts yourself, as far as you are able, and never implicitly adopt a character upon common fame ; which, though generally right as to the great outlines of characters, is always wrong in some particulars.

Be upon your guard against those who, upon very slight acquaintance, obtrude their unasked and unmerited friendship and confidence upon you ; for they probably cram you with them only for their own eating ; but at the same time, do not roughly reject them upon that general supposition : examine further and see whether those unexpected offers flow from a warm heart, and a silly head, or from a designing head and a cold heart ; for knavery and folly have often the same symptoms.

Never neglect or despise old for the sake of new or more shining acquaintance ; which would be ungrateful on your part, and never forgiven on theirs. Take care to make as many personal friends and as few personal enemies as possible. We do not mean, by personal friends, intimate and confidential friends, of which no man can hope to have half a dozen in the whole course of his life ; but we mean friends in the common acceptation of the word ; that is, people who speak well of you, and who would rather do

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good than harm, consistently with their own interest, and no farther.

Lying.

Nothing is more criminal, mean, or ridiculous than lying: it is the production either of malice, cowardice, or vanity; but it generally misses of its aim in every one of these views; for lies are always detected sooner or later. If we advance a malicious lie in order to affect any man's fortune or character, we may indeed injure him for some time; but we shall certainly be the greatest sufferers in the end: for as soon as we are detected, we are blasted for the infamous attempt; and whatever is said afterwards to the disadvantage of that person, however true, passes for calumny. To lie, or to equivocate (which is the same thing,) to excuse ourselves for what we have said or done, and to avoid the danger of the shame that we apprehend from it, we discover our fear as well as our falsehood; and only increase, instead of avoiding the danger and the shame; we shew ourselves to be the lowest and meanest of mankind, and are sure to be always treated as such. If we have the misfortune to be in the wrong, there is something noble in frankly owning it; it is the only way of atoning for it, and the only way to be forgiven. To remove a present danger by equivocating, evading, or shuffling, is something so despicable, and betrays so much fear, that whoever practices them deserves to be chastised.

There are people who indulge themselves in another sort of lying, which they reckon innocent, and which in one sense is so; for it hurts no body but themselves. This sort of lying is the spurious offspring of vanity, begotten upon folly: but he who will tell any lie from idle vanity, will not scruple telling a greater for interest.

Nothing but Truth can carry us through the world with either our conscience or our honour unwounded : it is not only our duty, but our interest ; as a proof of which, it may be observed, that the greatest fools are generally the greatest liars : we may safely judge of a man's truth by his understanding.

Pedantry.

Some learned men, proud of their knowledge, only speak to decide, and give judgment without appeal ; the consequence of which is, that mankind, provoked by the insult, and injured by the oppression, revolt ; and, in order to shake off the tyranny, even call the lawful authority in question : the more you know, the modestest you should be.

Others to shew their learning, or often from the prejudices of a school education, where they hear of nothing else, are always talking of the ancients as something more than men, and of the moderns as something less. Speak of the moderns without contempt, and of the ancients without idolatry.

There is another species of learned men, who though less dogmatical and supercilious, are not less impertinent. These are the communicative and shining pedants, who adorn their conversation, even with women, by happy quotations of Greek and Latin, and who have contracted such a familiarity with the Greek and Roman authors, that they call them by certain name or epithets denoting intimacy. As old Homer ; that sly old rogue Horace ; Maro, instead of Virgil ; and Naso instead of Ovid. These are often imitated by coxcombs, who have no learning at all ; but who have got some names, and some scraps of ancient authors by heart, which they improperly and impertinently retail in all companies, in hopes of passing for scholars. If therefore you would avoid the accusation of pedantry, on one hand, or the suspicion of ignorance, on the other abstain from

learned ostentation. Speak the language of the company you are in; speak it purely, and unlarded with any other. Never seem wiser, nor more learned, than the people you are with: wear your learning like your watch, in a private pocket; and not pull it out and strike it, merely to shew that you have one. If you are asked what o'clock it is, tell it; but do not proclaim it hourly and unasked, like a watchman.

Pleasure.

Many young people adopt pleasures, for which they have not the least taste, only because they are called by that name. They often mistake so totally, as to imagine that debauchery is pleasure; drunkenness, which is equally destructive to body and mind is certainly a fine pleasure! Gaming, which draws us into a thousand scrapes, leaves us penniless, and gives us the air and manners of outrageous madman, is another most exquisite pleasure.

Pleasure is the rock which most young people split upon; they launch out with crowded sails in quest of it; but without a compass to direct their course, or reason sufficient to steer the vessel; therefore pain and shame, instead of pleasure, are the returns of the voyage.

We may enjoy the pleasures of the table and wine, but stop short of the pains inseparably annexed to an excess in either: we may let other people do as they will without formally and sententiously rebuking them for it; but we must be firmly resolved not to destroy our own faculties and constitution, in compliance to those who have no regard to their own.

The more we apply to business, the more we relish our pleasures: the exercise of the mind in the morning, by study, whets the appetite for the pleasures of the evening, as the exercise of the body whets the appetite for dinner. Business and plea-

sure, rightly understood, mutually assist each other; instead of being enemies, as foolish or dull people often think them.

We cannot taste pleasure truly, unless we earn them by previous business; and few people do business, who do nothing else: but when we speak of pleasure, we mean the elegant pleasures of a rational being, and not the brutal ones of a swine.

Prejudices.

Never adopt the notions of any books you may read, or of any company you may keep, without examining whether they are just or not; as you will otherwise be hurried away by prejudices, instead of being guided by reason, and quietly cherish error, instead of seeking truth. Use and assert your own reason; reflect, examine, and analyze every thing in order to form a sound and mature judgment; let no *ipse dixit* impose upon your understanding, mislead your actions, or dictate your conversation. Consult your reason betimes, it will prove the least erring guide that you can follow: books and conversation may assist it, but adopt neither, blindly nor implicitly: try both by that best rule which God has given to direct us, Reason.

Local prejudices prevail only with the herd of mankind, and do not impose upon cultivated, informed, and reflecting minds: but then there are notions equally false, though not so glaringly absurd, which are entertained by people of superior and improved understandings, merely for the want of necessary pains to investigate, the proper attention to examine, and the penetration requisite to determine the truth. Those are the prejudices which we would have you guard against, by a manly exertion and attention of your reasoning faculty.

Religion.

Errors and mistakes, however gross, in matters of opinion, if they are sincere, are to be pitied ; but not punished nor laughed at. The blindness of the understanding, is as much to be pitied as the blindness of the eyes ; it is neither laughable nor criminal for a man to lose his way in either case : charity bids us endeavour to set him right, by arguments and persuasions ; but charity, at the same time, forbids us either to punish or ridicule his misfortunes. Every man seeks for truth, but God only knows who has found it. It is unjust to persecute, and absurd to ridicule people for their several opinions, which they cannot help entertaining upon the conviction of their reason. It is he who tells, or acts a lie, that is guilty, and not he who honestly and sincerely believes the lie. The object of all public worships in the world is the same ; it is that great Eternal Being who created every thing. The different manners of worship are by no means subjects of ridicule : each sect thinks his own the best ; and I know no infallible judge in this world to decide which is best.

Economy.

A fool squanders away, without credit or advantage to himself, more than a man of sense spends with both : the latter employs his money as he does his time, and never spends a shilling of the one, nor a minute of the other, but in something that is either useful or rationally pleasing to himself or others : the former buys whatever he does not want, he cannot withstand the charms of a toyshop ; snuff-boxes, canes, &c. are his destruction. Without care and method, the largest fortune will not supply the extravagant ; and with the economist, the smallest will

supply all necessary expences. Never from a mistaken economy, buy a thing you do not want, because it is cheap ; or from a silly pride, because it is dear. Keep an exact account of all the money that you receive, and of all that you pay ; for few men, who know what they receive, ruin themselves : but many people, particularly those in business, by keeping bad accounts, therefore not knowing the true state of their affairs, have launched out into such extravagancies, as have been the destruction of their families.

Friendship.

The greatest sweetner of human life is Friendship : to raise this to the highest pitch of enjoyment, is a secret which but few discover. Friendships, in general, are suddenly contracted ; and therefore it is no wonder they are easily dissolved. Young persons have commonly an ungarded frankness about them, which makes them the easy prey and bubbles of the artful and experienced ; they look upon every person who tells them he is their friend to be really so ; and pay that profession of simulated friendship with an indiscreet and unbounded confidence always to their loss, often to their ruin. Beware of these proffered friendships ; receive them with civility, but with great incredulity too ; and pay them with compliments, but not with confidence : do not suppose that people will become friends at first sight, or even upon a short acquaintance : real friendship is a slow grower ; and never thrives, unless ingrafted upon a stock of known and reciprocal merit.

There is a kind of nominal friendship amongst young people, which is warm for a time, but luckily of short duration : this friendship is hastily produced, by their being accidentally thrown together, and pursuing the same course of riot and debauchery ; a fine friendship truly ! and well cemented by drunkenness and lewd-

ness! it should rather be called a conspiracy against morals and good manners, and be punished as such by the civil magistrate: however they have the folly to call this confederacy a friendship. They oft engage in quarrels, offensive and defensive for their accomplices; they tell one another all they know, and often more too; when of a sudden some accident disperses them, and they think no more of each other, unless it be to betray and laugh at their imprudent confidence.

A man who has amused us for an evening with sprightly conversation, shall be admitted into the number of our friends, and received with that ardor which is always the attendant upon the first impression of regard: but though wit be an agreeable, it is by no means the only qualification necessary in a friend; and is of all others the most precarious foundation of esteem. Qualifications that make a man the object of general applause, are not in themselves sufficient to conciliate our friendly regards.

Remember to make a great difference between companions and friends; for a very complaisant and agreeable companion may, and often does, prove a very improper and a very dangerous friend. People will in a great degree, form their opinion of you, upon that which they have of your friends, "Tell me who you keep company with, and I will tell you who you are." One may fairly suppose, that a man, who makes a knave or a fool his friend, has something very bad to do, or to conceal: but at the same time that you carefully decline the friendship of knaves and fools, if it can be called friendship, there is no occasion to make either of them your enemies, wantonly and unprovoked; for they are numerous bodies; and one would rather chuse a secure neutrality, than alliance or war with either of them: you may be a declared enemy to their vices or follies, without being marked out by them as a personal one. Their

enmity is the next dangerous thing to their friendship: have a real reserve with almost every body; and have a seeming reserve with almost nobody; for it is very disagreeable to seem reserved, and very dangerous not to be so. Few people find the true medium; many are ridiculously mysterious and reserved upon trifles; and many imprudently communicative of all they know.

Look round the world, and you will see men employed in such pursuits, and disturbed with such passions, as make friendship appear an empty name, and an imaginary existence! Most breasts are so contracted by selfish and mercenary principles, that they are incapable of feeling any of the finer movements, and reciprocations of benevolence; and even where nature has softened the heart to this delicate sensibility, she has, perhaps, considerably abated its operation, by principles and habits of a contrary kind.—Some are susceptible of the warmest affection, quick to the call of necessity, and ready to relieve and succour distress; but then they lie open to the attack of every softer passion, and have not fortitude sufficient to reason down these rising propensities of nature into the genuine principle of disinterested friendship.—Others from selfishness and pride, shall lend an ear to the whisper of malignity and envy; others have hearts soft to every impression; and in these, one seal of friendship is obliterated by another; while some by a mutable disposition of mind, relinquish their friends, not because they cease to be, but continue what they once were: but when we come to reflect, on the one hand, that friendship, in order to be true and lasting, must know no rival or reserve, have similar virtues for its foundation, and mutual esteem for its support; and when we consider, on the other, the suspicions of pride, the love of superiority, and the natural distrust of the human heart, we shall soon find that Socrates made a right estimate of friendship, and that a very small mansion will con-

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tain those which any man can truly call as such, and, as Dr. YOUNG very justly observes,

“ But since friends grow not thick on ev’ry bough,
Nor ev’ry friend unrotten at the core;
First on thy friend, delib’rate with thyself;
Pause, ponder, sift; nor eager in the choice,
Nor jealous of the chosen: fixing, fix;
Judge before friendship; then confide till death.”

But though we may not arrive at all that happiness which we are assured a pure friendship is capable of affording, yet this ought not to make us indolent in our researches, or indifferent in our regards: that man would be thought very unreasonable, who should refuse to partake of the elegancies which his own country affords, because other regions furnish out greater delicacies; for as the author just quoted, says,

“ Friendship’s the wine of life; but friendship new
Is neither strong nor clear:
O! for the bright complexion, cordial warmth
And elevating spirit of a Friend,
For twenty summers rip’ning by my side;
All feculence of fallhood long thrown down;
All social virtues rising in his soul;
As crystal clear; and smiling as they rise!
Here nectar flows; it sparkles in our sight;
Rich to the taste, and genuine from the heart.”

The very constitution of our minds leads us immediately to the cultivation of friendship; for

“ Poor is the friendless master of a world:
A world in purchase for a friend is gain.”

Though the powers of the mind are great, yet, the wider they expand, the less forcible they act;

that benevolence we feel towards all mankind, is of so undeterminate a nature, that when the general calamities of our fellow creatures are represented to us, where, perhaps, whole nations are immediate sufferers, we enter not into that sympathy which we should feel for one family or friend in distress. We shall always find, that, in exact proportion as the objects of our benevolence decreases, the more warm and lively our benevolence operates. The good of the political community to which we belong, is more the object of our regards than the community of the world; that of our families and friends, more than that of the political community; and that of an individual, is still more sacred and dear. Here our regards center upon an absolute object, and there is more than general calamity to affect us. When one particular ear is open to our complaints; when we see one breast filled with sympathy; the eye of an individual flowing with a tear of compassion, or glad with the sparkling of joy: we imagine this to be an extraordinary instance of that humanity, which, in every instance, gains our esteem and approbation, but when shewn to ourselves, esteem and love.

The requisites of friendship, are confidence, love, and esteem; such as are founded upon similar perfections of character, or similar taste, with no more opposition of sentiment, than what shall sometimes prove a gentle excitement to an amicable dispute. We cannot confide in the man whose moroseness makes him reserved, any more than in him, whose levity makes him liable to change; we cannot trust the man of pride, or commit a secret to his keeping, who is always unguarded: we must both love and esteem the person we admit to our friendship; because a man may possess qualities which may produce love, and no esteem; or esteem without love: the former is founded on qualifications that please, the latter on those that command approbation. We in some sort, love ourselves in our friend,

and are glad, from a desire of appearing disinterested, to make a joint offering to benevolence, and self-love. The foundation of this must be, the similarity between ourselves and our friend: the same taste that leads to the same pleasures, binds us most forcibly with the cords of affection. We love to recollect, much more constantly converse, with objects with which we have connected the most agreeable ideas: and, by this joint participation, we give a continuance to pleasures otherwise fugitive, and of precarious remembrance. Such an opposition of sentiment in friendship must never appear, as may lead us to espouse the causes of different parties: in contentions, which these produce, friendship has been often destroyed, without the conviction of either of the opponents.

When once we have made choice of a friend, let us care to keep him be equal to the value of the possession we enjoy: and let us remember the imperfections of humanity, and expect not too much even from friendship itself.—we may trust in the sincerity of a friend; but there are secrets which no other breast but our own should be conscious of. We may reveal many griefs, but a portion ought to be reserved as a trial of our own fortitude. We may communicate many pleasures, yet still have some in reserve; there will be seasons when these may amuse, and when a friend cannot delight. Friendship may be made subservient to the noblest purposes of humanity: though it will not allow of direct opposition, sentiment, or the contention of superiority, yet it admits of a generous emulation who shall excel in all the amiable virtues, that connect mankind in the inviolable union of social benevolence.

CHAP. VII.

BIRDS.

Their Variety, Sagacity, Industry, Instinct of Incubation, and particular Care to feed and protect their Young. &c.

SO numerous are the different kinds of birds, that it is supposed five hundred different kinds is short of the number; such great variety is there of those sagacious creatures! We see a surprizing degree of reason in several animals, but it no where appears in a more sensible manner than in the industry of birds in building their nests. In the first place, what master taught them that they have need of such habitations? who has taken care to inform them to prepare them to time, and not suffer themselves to be prevented by necessity? who has told them how they should build them? what mathematician has given them the figure of them? what architect has taught them to chuse a firm place, and to build upon a solid foundation? what tender mother has advised them to cover the bottom with a soft down or cotton? and when these matters fail, who has suggested to them that ingenious charity, which leads them to pluck off so many feathers from their own breasts with their beaks, as is requisite for the preparing a convenient cradle for their young? What wisdom has pointed out to every distinct kind a peculiar manner of building their nests, so as to observe the same precautions, though in a thousand different ways? Who has commanded the Swallow, the skilfullest of birds, to draw near to man, and make choice of his house for the building of his nest,

within his view, without fear of his knowing it, and seeming rather to invite him to a consideration of his labour? neither does he build like other birds with little bits of sticks and stubble, but employs cement and mortar, and in so solid a manner, that it requires some pains to demolish its work; and yet in all this it makes use of no other instrument but its beak. Reduce, if it is possible, the ablest architect to the small bulk of a swallow, and leave him all his knowledge, and only a beak, and see if he will have the same skill and the like success.

Who has made all the birds comprehend that they must hatch their eggs by sitting upon them? that this necessity was indispensable? that the father and mother could not leave them at the same time, that if one went abroad to seek for food, the other must wait till it returns? who has fixed the number of days this painful diligence is to last? who has advised them to assist the young that are already formed in coming out of the egg by first breaking the shell? and who has so exactly instructed them in the very moment, before which they never come? who has given lessons to all the birds upon the care they ought to take of their young, till such time as they are grown up, and in condition to provide for themselves? Who has made them to distinguish such such things as agree well with one species, but are prejudicial to another? and amongst such things as are proper for the parents, and unfit for the young, who has made them to distinguish such as are salutary? We know the tenderness of mothers and the carefulness of nurses amongst mankind, but we may question whether it ever came up to what we see in these little creatures. It is remarkable, that birds which feed their young in the nest, who bring but one morsel at a time, and have not fewer, it may be, than seven or eight young in the nest together, which at the return of the dam all gape together, yet she forgets not one of them, but feeds

them all ; which, unless she did carefully observe and retain in the memory which she fed, and which not, were impossible to be done. To prove still further the sagacity of birds, Dr. LISTER, and others have observed, that when they have laid such a number of eggs as they can conveniently cover and hatch, they give over, and begin to sit ; not because they are necessarily determined to such a number ; for that they are not is clear, because they are in ability to go on and lay more at pleasure : Hens for example, let but their eggs alone, and when they have laid fourteen or fifteen, will give over, and begin to sit ; whereas if you daily withdraw their eggs, they will lay five times that number : (yet some birds are so cunning, that if you leave them but one egg, they will forsake the nest,) and this is the same in wild as tame domestic birds. It has been observed, that by subtracting daily of the eggs from a Swallow's nest, that she proceeded to lay nineteen eggs and then gave over. An ingenious author has remarked, that of the common Crow, the female only sit, and that diligently ; the male in the mean time bring them victuals. In most other birds, which pair together, the male and female sit by turns ; the female crows are much fatter than the males in the time of incubation, by reason the male, out of his conjugal affection, almost starves himself, to supply the female with plenty. Who has taught several among the birds that marvellous industry of retaining food or water in the gullet, without swallowing either the one or the other, and preserving them for their young ? We may learn an useful lesson from them, which is, they never omit instructing them to fly ; for the young birds dare not trust themselves to the air, till they are first instructed and brought to it by their parents. And, as Mr. THOMSON justly observes,

Till down before them fly
The parent guides, and chide, exhort, command,

Or push them off, the surging air receives
The plummy burthen; and their self-taught wings
Winnow the waving element : on ground alighted,
Bolder up again they lead,
Farther and farther on, the length'ning flight ;
Till vanish'd every fear and every power
Rouz'd into life and action, light in air
Th' joyful parents see their soaring race.

If man had but as much true love for his offspring
as the birds, even the poorest would pinch, to spare
every necessary expence for their children to feed,
cloath and instruct them in all the duties requisite to
make life happy, and death no terror.

What can be more delightful than a concert of
music performed by those sagacious animals ! theirs
was the first praise which God received from nature,
and the first song of thanksgiving which was offered
to him before man was formed. All their sounds are
different, but all harmonious, and all together com-
pose one choir which men have but sordily imitated.
One voice however, more strong and melodious, is
distinguished among the rest, and we find upon en-
quiry from whence it comes, that it is a very small
bird, which is the organ of it : this may lead us
to consider all the rest of the singing tribe, as they
also are small ; the great ones being either ignorant
of music, or having a disagreeable voice. Thus we
every where find that what seems weak and humble,
has the best destination, and the most gratitude.
Some of these little birds are extremely beautiful ;
nor can any thing be more rich or variegated than
their feathers ; but it must be owned that all orna-
ment must give place to the finery of the Peacock,
upon which the Deity has plentifully bestowed all
the riches which set off the rest, and lavished upon
it with gold and azure all the shades of every other
colour. This bird seems sensible of its advantage,

and looks as if it designed to display all its beauties to our eyes, when it expands that splendid circumference which sets them all to view. But this most pompous bird of all, has a most disagreeable cry, and is a proof, that with a very shining outside, there may be but a sorry substance within; little gratitude, and a great deal of vanity.

In examining the feathers of water fowl, such as Swans, Ducks, &c. we find one thing very singular, for they are proof against the water, and continue always dry, and yet our eyes do not discover either the artifice or difference of them; observe the webs of their feet, and they mark their destination, for other birds to whom God has not given the like feathers or feet, are never so rash as to expose themselves to danger: but who has told the former they run no danger, and who keeps back the latter from following the example? It is not unusual to see Duck eggs under a Hen, which in this case is deceived by her affection, and takes a foreign brood for her natural offspring; they run to the water as they come out of the shell, nor can their pretended mother prevent them by her repeated calls; she stands upon the brink in astonishment at their rashness, and still more at the success of it: she finds herself violently tempted to follow them, and warmly expresses her impatience, but nothing is capable of carrying her to an indiscretion which God has prohibited. Spectators are surprized at it, more or less in proportion to their understandings; the want of which is the cause when such prodigies excite so little admiration!

Relative to birds of passage we shall conclude with observing, that there is amongst every sort of birds a republic and general rule of government, which guides and restrains every single bird in its duty: before the general edict there is none thinks of departing: after its publication, there is none tarries behind: a kind of council fixes the day, and grants certain time to prepare for it; after which they a

take their flight, and so exact in their discipline, that the next day there is not a straggler or deserter to be found. Many people know no other bird but the Swallow, that acts thus; but it is certain that many other species do the same. Ask of the Swallows what news they have received from the countries whither they go in great companies, to be assured that they shall find all things ready for their reception? We ask why do they not keep like other birds to the country where they have brought up their young, which have been so kindly treated in it? By what disposition to travel does this new brood, which knows no other than its native country, conspire at once to quit it? in what language is the ordinance published, which forbids all, both old and new subjects of the republic, to tarry beyond a certain day? and lastly, by what signs do the principal magistrates know that they should run an extreme hazard in exposing themselves to be prevented by a rigorous season? What other answer can be given to these, than that of the prophet, O Lord, how manifold are Thy works! in wisdom hast thou made them all. PSAL. ciii. ver. 24.

Delighted with the music of the tuneful tribe, so let our hearts be prompted to join their melody by more rational notes, and send up the breath of praise, with the odours of the morning to our common Benefactor.

CHAP. VIII.

A N I M A L S.

INGENIOUS men who have taken pains to examine the amazing wonders of the creation, assure us, that they have found no less than one hundred and fifty entire different kinds of beasts or four-footed creatures.

The most accurate mathematician, the most skilful in mechanics cannot prescribe a nicer motion than what they perform, neither can the body be more completely poised for the motion it is to have in every creature than it already actually is. From the largest Elephant to the smallest mite, we find the body artfully ballanced, the head not too heavy nor too light for the rest of the body, nor the body for it. If all the animals of our globe had been made and placed by chance, their organs would probably have been otherwise than they are, and their place and residence confuse and jumbled; but as the matter is now ordered, the globe is equally bespread, so that no place wanteth proper inhabitants, nor is any creature destitute of a proper place, and all things necessary to its life, health, and pleasure. As the surface of the terraqueous globe is covered with different soils, with hills and vales, &c. so all these have their animal inhabitants, whose organs of life and action are manifestly adapted to such and such places and things; whose food and phyfic and every other convenience of life, is to be met with at that very place appointed it. The watery, the amphibious, the airy inhabitants, and those on the land, all live and act with pleasure, they are gay, and flourish in their proper element and allotted place, they want neither for food, cloathing, or retreat; which would dwindle

and die, destroy or poison one another, if all coveted the same element, place, or food. The whole surface of our globe can afford room and support only to such a number of all sorts of creatures; and if by their doubling, trebling, or any other multiplication of their kind, they should increase to double or treble that number, they must starve, or devour one another: the keeping therefore the balance even, is manifestly a work of Divine wisdom and providence: to which end the great Author of life hath determined the life of all creatures to such a length and their increase to such a number, proportional to their use in the world. The life of some creatures is long, and their increase but small, by that means they do not overstock the world; and the same benefit is effected, where the increase is great, by the brevity of such creatures lives, by their great use, and the frequent occasions there are of them for food to man, or other animals. It is very remarkable, useful creatures are produced in great plenty, others in less. But there is one so peculiar an animal, as if made for a particular instance in our present case, and that is the *Cuntur of Peru*, a fowl of that magnitude, strength, and appetite, as to seize not only on the sheep, and lesser cattle, but even the larger beasts, yea the very children too; this bird measures sixteen foot from wing to wing extended; the chief feather in the wing is two foot four inches long; the quill part five inches and three quarters long, and one inch and a half about in the thickest part: it weighed three drams seventeen grains and a half, and is of a dark brown colour. Nature, to temper and allay their fierceness, denied them the talons which are given to the Eagle; their feet being tipped with claws like a Hen: however their beak is strong enough to tear off the hide, and rip up the bowels of an Ox, two of them will attempt a Cow or a Bull, and devour him; they have assaulted boys of ten years of

age, and eaten them. Their colour is black and white, like a Magpye; it is well there are but few of them; for if there were many, they would very much destroy the cattle: they have on the fore part of the head a comb, in the form of a razor: when they alight from the air, they make such a humming noise, with the fluttering of their wings, as is enough to astonish or make a man deaf: now these, as they are the most pernicious of birds, so are they the most rare, being seldom seen, or only one, or a few in large countries; enough to keep up the species, but not to overcharge the world. Thus the balance of the animal world is throughout all ages, kept even; and by a curious harmony, and just proportion between the increase of all animals, and the length of their lives, the world is through all ages, well, but not over stored.

It is a great act of power, wisdom, and goodness, in the Deity, to provide food for such a number of animals, as every where possess the terraqueous globe; that the temperate climates, and rich and plentiful regions of the earth, should afford subsistence to many animals, may appear less wonderful, perhaps; but that in all other the most unlikely places for supplies is found such a vast number, so great a variety of beasts, birds, fishes, and insects, which is owing to that Being, who hath wisely adapted their bodies to their place, and as well and carefully provided food for their subsistence there: but what is particularly remarkable is, that among the great variety of foods, the most useful is the most plentiful, most universal, easiest propagated, and most patient of weather and other injuries. There is an excellent provision made relating to the food of animals, that is various animals delight in various food; some in grass and herbs, some in grain and seeds; some in flesh, some in insects; some are more delicate; others are voracious, and catch at any thing. If all delighted in, or subsisted only with one sort, there would not be

sufficient for all ; but every variety chusing various food, and perhaps, abhorring that which others like, is a great and wise means that every kind hath enough, and oftentimes to spare : what is wholesome food to one, is nauseous and as poison to another ; what as a sweet and delicate smell and taste to one, is foetid and loathsome to another ; by which means all the provisions the globe affords are well disposed of.

To prove the sagacity of animals, the celebrated physician Galen, relates in his writings an extraordinary and wonderful instance of the self-taught actions of animals : “ I once (says he) made a great experiment in bringing up a kid without ever seeing its dam ; for dissecting some goats great with young ; to resolve some questions made by anatomists concerning the œconomy of nature in the formation of the young in the womb, and finding a brisk young one, I loosed it from the womb after our usual manner, and snatching it away before it saw the dam, I brought it into a certain room, having many vessels full, some of wine, some of oil, some of honey, some of milk, or other liquor ; and others, not a few, filled with all sorts of grain, as also with several fruits, and there laid it. This young one we saw first of all getting upon its feet and walking, as if it had heard that its legs were given it for that purpose ; next shaking off the slime it was besmear’d with from the womb ; and moreover, thirdly, scratching its side with one of its feet ; then we saw it smelling of every one of those things that were set in the room ; and when it had smelt of them all, it supped up the milk ; whereupon we all for admiration cry’d out, seeing clearly the truth of what Hippocrates saith, That the natures and actions of animals are not taught but by instinct : hereupon I nourished and reared this Kid, and observed it afterwards not only to eat milk but some other things that stood by it : and the time

when this Kid was taken out of the womb being about spring time, after some two months, were brought into it the tender sprouts of shrubs and plants, and it again smelling of all of them, instantly refused some, but was pleased to taste others; after it had tasted, began to eat of such as are the usual food of Goats. Perchance this may seem a small thing, but what I now relate is great; for eating the leaves and tender sprouts, it swallowed them down, and then awhile after it began to chew the cud; at which, all that saw cry'd out again with admiration, being astonished at the instinct and natural faculties of animals; for it was no great thing that when the creature was hungry, it should take in the food by the mouth, and chew it with its teeth; but that it should bring up again into the mouth that which it had swallowed down into its first stomach, and chewing it there a long time, it should grind and smoothen it, afterwards swallow it again, not into the same stomach, but into another, seemed to us wonderful indeed; but many neglect such works of nature, admiring only strange and unusual sights."

What an admirable and curious apparatus is the mouth of all animals, made for the gathering, preparing, and digestion of food! from the very first entrance, to the utmost exit, we find every thing contrived, made and disposed with the utmost dexterity of art, and curiously adapted to the place the animal liveth in, and the food it is to be nourished with. We find the mouth is, in every species of animals, nicely conformable to the use of such a part, neatly sized and shaped for the catching of prey, for the gathering or receiving food, for the formation of speech, and every other use: in some creatures it is wide, in some little and narrow; in some with a deep incisure up into the head for the better catching and holding of prey, and more easy comminution of hard, large, and troublesome food; in others with a much shorter incisure for the gathering and holding of her-

bacious food ; many more have their mouths strongly furnished with jaws and teeth, to knaw and scrape out their food, to carry burdens, to perforate the earth, yea the hardest wood, even the stones themselves, for houses for their young. Lastly, in birds it is no less remarkable ; for they are neatly shaped for piercing the air, and making way for the body through the airy regions ; the bill is hard and horny, which is a good supplement for the want of teeth, and causeth it to have the use and service of the hand : its hooked form is of great use to the rapacious kind, in catching and holding their prey, and in the comminution thereof by tearing ; to others it is no less serviceable to their climbing, as well as neat and nice manner of dividing their food ; for instance, Parrots, by the lower jaw being compleatly fitted to the hooks of the upper, they can as minutely break their food, as other animals do with their teeth : the extraordinary length and slenderness of the beak is very useful to some, to search and grope for their food in mouldy places ; as its length and breadth is to others, to hunt and search in muddy places : and the contrary form, namely, a thick, short, and sharp edged bill, is as useful to other birds, who have occasion to husk and flay the grains they swallow : but it would be endless to reckon up the various shapes, and commodious mechanism of all ; the sharpness and strength of those who have occasion to perforate wood and shells ; the slenderness and neatness of such as pick up small insects ; the cross form of such as pick up fruits, the compressed form of others, with many other curious and artificial forms, all suited to the way of living, and peculiar occasions of the several species of birds.

We shall next take a short view of the teeth of different animals : those which have teeth on both jaws, have but one stomach ; but most of those which have no upper teeth or none at all, have three sto-

machs, as in beasts, the paunch, the read, and the feck; and in granivorous birds, the crop, the echinus, and the gizzard; for as chewing is to an easy digestion, so is swallowing whole to that which is laborious. Their peculiar hardness is remarkable, also their firm insertion and bandage in the gums and jaws, and their various shape and strength, suited to the various occasions and use; the foremost weak and farthest from the centre, as being only preparers to the rest; the others being to grind and mince, are accordingly made stronger, and placed nearer the centre of motion and strength: had the grinders been set in the room of the incisors or single teeth, they would have been useless. It is remarkable in what a curious manner the teeth are fitted in the sockets, which being no less accurately done, than what is performed by the most ingenious carpenter in fitting a tenon into a mortice, doth as well infer the art and act of the wise Maker of animal bodies, as the other doth the act and art of man. Next to the mouth, the gullet presenteth itself; in every creature well sized to the food it hath occasion to swallow; in some but narrow, in others as large and extensive; in all exceedingly remarkable for the curious mechanism of the muscles, and the artificial decussation and position of their fibres. And now we are arrived at the grand receptacle the stomach; for the most part as various as the food to be conveyed therein: it is observable that in every species of animals, the strength and size of their stomach is conformable to their food. Such whose food is more delicate, tender, and nutritive, have commonly this part thinner, weaker, and less bulky; whereas such whose aliment is less nutritive, or whose bodies require larger supplies to answer their bulk, their labours, and waste of strength and spirits, in them it is large and strong: but as remarkable a thing as any in this part of animals, is the curious contrivance and fabric of the ventricles of ruminating creatures: the

very act itself of rumination is an excellent provision for the compleat mastication of the food, at the leisure times of the animal ; but the apparatus for this service, of divers ventricles for its various uses and purposes, together with their curious mechanism, deserves great admiration.

What an astonishing faculty is that of many animals to discover their prey at vast distances ; some by their smelling many miles off ; and some by their sharp piercing sight aloft in the air, or at other great distances ! What a commodious provision hath the Contriver of nature made for animals, that are necessitated to climb for their food, not only in the structure of their legs and feet, and in the strength of their tendons and muscles, acting in that office ; but also in the peculiar structure of the principal parts, acting in the acquirement of their food. What a provision also is that in nocturnal animals, the peculiar structure of the eye ; thus Cats (their pupils being erect, and the shutting their eyelids transverse thereto) can so close their pupil, as to admit of, as it were, only one single ray of light ; and by throwing all open, they can take in all the faintest rays ; which is an incomparable provision for these animals, that have occasion to watch and way lay their prey both by day and night. There is, besides this large opening of the pupil, in some nocturnal animals, another admirable provision, enabling them to catch their prey in the dark ; which is a radication or shining of the retina at the bottom of the eye : this is most remarkable in Cats, but is not at all in either men, birds, or fishes ; as they have not occasion for it, as having no necessity of providing their food by night, so we find they have no such radication. This shining of the retina enables Cats to catch and destroy those animals which are noxious to us, and food for them ; which could not be done by day, because such animals seldom stir out of their holes till the night time.

It deserveth our special notice, that these are in divers animals of divers forms, according to their peculiar occasions: in some animals it is of a longish form; in others (such as goats, horses, sheep, &c.) transverse, with its aperture large; which is a very proper provision for such creatures the better laterally, and thereby avoid inconveniencies, as well as to help them to gather their food on the ground, both by day and night. In other animals the fissure of the pupil is erect and also capable of opening wide, and shutting up close; the latter of which serves to exclude the greater light of the day, and the former to take in the more faint rays of the night. Another thing observable in the sight of the eye, is the manner of its situation in the head, in the forepart, or side thereof, according to the particular occasions of different animals; in man and some other creatures, it is placed to look directly forward chiefly; but withal it is so ordered, as to take in near the Hemisphere before it: in birds, and some other creatures, the eyes are so seated, as to take in near a whole sphere, that they may the better seek their food, and escape dangers: and in some creatures they are seated so as to see their enemy that pursues them, that way, and so make their escape. Thus in Hares and Conies their eyes are very protuberant, and placed so much towards the sides of the head, that their eyes take in nearly a whole sphere; whereas in Dogs (that pursue them) the eyes are set more forward in the head, to look that way more than backward.

The Scriptures teach us that God's care and wisdom is over all his works, the meanest and most minute, as well as the larger ones; thus Snails, not being able to turn their head quick from side to side; their eyes are not placed in their head, but at the end of their long horns, which we find they twist and turn about with great ease and agility.

Spiders being to live by catching so nimble a prey as a fly is, it was necessary they should see her every

way, and take her by a sudden spring (as they do) without any motion of the head to find her out; which motion would have scared away so timorous an insect: accordingly, we find that Spiders have no necks, so that they cannot move their heads; but then they are furnished some with four, and others with six, seven, and eight very transparent eyes placed in the front of their heads. In the same manner, there seems to have been the like consideration had to the pleasure and benefit of the Mole, in the structure of its eye; for as the habitation of that animal is wholly subterraneous, and its lodgings, its food, its exercises, nay even all its pastimes and pleasures, in those subterraneous recesses and passages which its own industry hath made for itself; so there is an excellent provision made in the size of the eye of that little creature, to answer all its occasions, and at the same time to prevent inconveniencies; for as little light will suffice an animal living always under ground, the smallest eye will abundantly supply that occasion: and as a large protuberant eye, like of other animals, would much annoy this creature in its principal business of digging for its food and passage, so it is endowed with a very small one commodiously situated in the head, and well fenced and guarded against the annoyances of the earth: and the same respect we shall find had in the formation of the eye to the particular circumstances and way of life of every other creature.

It is observed by anatomists, that horses, beasts, sheep, and other animals which feed upon grass and herbs, and are therefore obliged to hang down their heads a great deal in chusing and gathering their food, have a particular muscle to sustain the eye, to prevent its being hurt with too much suspension; which is not to be found in man or any other animal who have not occasion to hang down their heads so frequently.

It is also evident that there is a very curious and extraordinary formation of the eye bestowed on birds and fishes, different from either man or beast, which enables those creatures to see at all distances, far off or nigh; which (especially in waters) requireth a different conformation of the eye: in birds also this is of great use, to enable them to see their food at their bills end, or to reach the utmost distances their high flights enable them to view; as to see over great tracts of sea or land, whither they have occasion to fly; or to see their food or prey, even small fishes in the waters, and birds, worms, &c. on the earth, when they sit upon trees, high rocks, or hovering high in the air. Du Hamel tells us of a singular conformity in the Cormorant's eye, and that is, that the crystalline is globous, as in fishes, to enable it to see and pursue its prey under water; which "J. FABER, in Mr. Willoughby, saith they do with amazing swiftness." We likewise find that the eyes of birds, beasts, and fishes, are defended by a membrane of the nature and hardness of bone or horn; which membrane man has not, he having little occasion to thrust his head into such places of annoyance, as beasts, and other animals; or if he hath he can defend his eyes with his hands: but birds, who frequent trees and bushes, quadrupeds and hedges and long grass, and who have no part ready, like the hand, to fence off annoyances; these have this incomparable provision made for the safety of their eyes: and for fishes, as they are destitute of eyelids, because there is no occasion for a defensive against dust and motes, offensive to the eyes of land animals, nor to moisten and wipe the eyes, as the eyelids do, so the nictitating membrane is an attendant provision for all their occasions, without the addition of the eye-lids: and for creatures, whose eyes, like the rest of their bodies, are tender, and without the guard of bones, there nature hath provided for this necessary and tender sense; a won-

derful kind of guard, by endowing the creature with a faculty of withdrawing its head, and lodging them in the same safety with the body.

Among all the instances we have of natural instinct, those instincts, and especial provisions, made to supply the necessities of helpless animals, do, in a particular manner, demonstrate the great Creator's care. With what alacrity do the animals transact their parental ministry! what surprizing care they take to nurse and provide for their young! they think no pains too great to be taken for them, no dangers, though ever so imminent, but they will undertake for their guard and security! how carefully will they lead them about in places of safety, and carry them into places of retreat and security; yea some of them will admit them into their own bowels! they caress them with their affectionate notes, lull and quiet them with their tender parental voice, put food into their mouths, suckle them, cherish and keep them warm, teach them to gather food for themselves; and in a word, perform the whole part of so many nurses, deputed by the sovereign Lord and preserver of the world to help such young and helpless creatures, till they are come to that maturity as to be able to provide for themselves!

What a surprizing provision there is made for the preservation of such animals as are sometimes destitute of food, or in danger of being so. The winter is a very inconvenient, improper season, to afford either food or exercise to many animals: when the flowery fields are divested of their gaiety; when the fertile trees and plants are stripped of their fruits, and the air, instead of being warmed with the cherishing beams of the sun, is chilled with rigid frost; what would become of such animals as are impatient of cold? what food could be found by such as are subsisted by the summer fruits? but to obviate this evil, to save from destruction, and a total extirpation of divers species of animals, the Omnipotent hath

wisely ordered the matter; that, in the first place, such as are impatient of cold, should have such a special structure of their body, particularly of their hearts, and circulation of their blood, as during that season, not to suffer any waste of their bodies, and consequently not to need any recruits; but that they should be able to live in a kind of sleepy, middle state, in their places of safe retreat, until the warm sun revives both them and their food together. The next provision is for such as can bear the cold, but would want food then; in others by their notable instinct in laying up food beforehand against the approaching winter: of this many entertaining examples may be given; particularly we may, at the proper season, observe not only little treasures and holes well stocked with timely provisions, but large fields here and there throughout bespread with considerable numbers of the fruits of the neighbouring trees, laid carefully up in the earth, and covered safe by the provident little animals inhabiting thereabouts. And not without pleasure, have we seen and admired the sagacity of other animals, hunting out those subterraneous fruits, and pillaging the treasures of those little creatures.

Another necessary appendage of life, and in which we have plain tokens of the Creator's art, manifested in these two particulars; the suitableness of animals cloathing to their place and occasions; and the garniture and beauty thereof. We find all is curious and complete, nothing too much, nothing too little nor bungling, nothing but what will bear the scrutiny of the most exquisite artists; yea, and so far outdo his best skill, that his most exquisite imitations, even of the meanest hair, feather, scale or shell, will be found only so many ugly, ill-made blunders and blotches, when strictly brought to the test of good glasses.

What care, wisdom and goodness, the Almighty shewed to his creatures, that they should come into

the world with their bodies ready furnished and accommodated, who had neither reason or forecast to contrive, nor parts adapted to the artifices and workmanship. To quadrupeds hair is a commodious cloathing; which together with the apt texture of their skin, fitteth them for all weathers to lie on the ground, and to do the offices of man; and the thick and warm furs of others are not only a good defensive against the cold and wet; but also a soft bed to repose themselves in; and to many of them a comfortable covering, to nurse and cherish their young. So feathers are as commodious a dress to such as fly in the air, to birds and some insects; not only a guard against wet and cold, but a comfortable provision to such as hatch and brood their young; but also most commodious for their flight; to which purpose they are nicely and neatly placed, to give them an easy passage through the air, and to assist them in waisting their bodies through that thin medium: for which service, how curious is their texture! hollow and thin for lightness, but context and firm for strength.

Lastly we shall take a short view of the garniture and beauty of their cloathing; and here we shall thus far, at least, descry it to be beautiful: that, that it is complete and workman-like. Even the cloathing of the most sordid animals, those that are the least beautified with colours, or rather whose cloathing may regrade the eye; yet when we come strictly to view them, and seriously consider the nice mechanism of one part, the admirable texture of another, and the exact symmetry of the whole; we discern such strokes of inimitable skill, such incomparable curiosity, that we may say with Solomon, (ECCLES. iii. 11.) "God hath made every thing beautiful in his time."

But for a further demonstration of the super-eminent dexterity of his almighty hand, he hath been pleased, as it were on purpose, to give surprizing

beauties to divers kinds of animals. What radiant colours are many of them, particularly some birds and insects, bedecked with ! what a prodigious combination is there often of these, yea, how nice an hair of meaner colours, as to captivate the eye of all beholders, and exceed the dexterity of the most exquisite pencil to copy.

And now, when we thus find a whole world of animals, cloathed in the wisest manner, the most suitable to the element in which they live, the place in which they reside, and their state and occasions there ; when those that are able to shift for themselves, are left to their own discretion and diligence, but the helpless well accoutered and provided for ; when such incomparable strokes of art and workmanship appears in all, and such inimitable glories and beauties in the cloathing of others ; who can with the greatest obstinacy and prejudice deny this to be God's handy-work ? the gaudy, or even the meanest apparel, which man provideth for himself, we readily enough own to be the contrivance of man : and shall we deny the cloathing of all the animal world besides (which infinitely surpasseth all the robes of earthly majesty ; shall we, dare we, deny that) to be the work of any thing less than of an infinite, intelligent Being, whose art and power are equal to such glorious works !

CHAP. IX.

FISHES.

Their Variety and wonderful Structure.

WHAT an abundance of fish do the waters produce of every size! when we view these animals we seem to discern nothing besides a head and tail: their very head cannot freely be moved; we should think them deprived of all that was necessary for the preservation of their lives; but with these few organs, they are more nimble, dexterous, and artificial, than if they had several hands and feet; and the use they make of their tail and fins, carries them along like arrows and seems to make them fly. As the fish devour one another, how can these watery inhabitants subsist? God has provided for it, by multiplying them in so prodigious a manner, that their fruitfulness infinitely surpasses their mutual desire of eating one another; and what is destroyed is far inferior to their increase: the little ones escape the great by being swifter and swimming into places where the shallowness of the water will not permit the great fish to follow. And whence comes it, that the fish live in the midst of waters so loaded with salt, that we can scarce bear a drop of them in our mouths, and enjoy there a perfect vigour and health, and how do they preserve in the midst of salt, a flesh that has not the least taste of it? why do the best, and such as are most fit for the use of man, draw near the coasts to offer themselves in a manner to him; whilst a great many others, which are useless, affect remoteness from him? why do those, who keep themselves in unknown places, whilst they multiply and acquire a certain bulk, come

in shoals at a particular time to invite the fishermen, and throw themselves in a manner into their nets and boats? why do several of them, and of the best kinds, enter the mouths of rivers, and run up even to their springs to communicate the advantages of the sea to such countries as lie at a distance from it? There are many hundreds of ships every year taking cod at the bank of *Newfoundland*, who generally carry away above twenty thousand cod each, but though this vast yearly consumption has been made for near two hundred years past, yet the same plenty of them still continues. What hand but thine, O Lord, conducts them to our coasts for the service of ungrateful man: Thy providence is every where to be discerned. The innumerable shells which are spread upon the shore, hide different kinds of fish; that with a very small appearance of life, are sure to open their shells at certain regular times to take in fresh water, and retain therein, by speedily joining them together, the imprudent prey which falls into that snare. Thus we may observe how innumerable are the proofs of the wisdom of that Being, who spoke, and brought, ten thousand, thousand, rolling worlds, from an immediate state of absolute insensibility.

Insects.

Their Policy, Sagacity, Industry, and Care of their Eggs and Young.

As none of the insect tribe shew greater marks of policy and industry than the Bee, we shall first endeavour to shew, that amongst the best governed nations in the universe, we have never yet found a government ruled so equitably as that of the Bees. In

this republic or mornarchy there is no idleness, no avarice or self-love, but all is common ; what is necessary is granted to all, a superfluity to none, and it is for the public good that their substance is preserved. New colonies, which would be a burthen to the state are sent abroad : they know how to work, and are obliged to do so, by being dismissed. Their industry is equal to their policy, for instead of contenting themselves with sucking the honey which is better preserved in the cups of flowers than any where else, and feeding upon it day by day, they lay up a provision for the whole year, and principally for the winter. The Bee loads the little hooks which adorn its legs with all the wax and gum that it can carry, and in sucking up the honey with the trunk fixed at the extremity of its head, it avoids the daubing of its wings, of which it stands in need to fly from place to place, and carry it home. If care is not taken to provide a hive for them, they make one in the hollow of some tree or rock ; their first care is to form the comb, which is composed of small equal cells that they may be the better joined, and leave no interval or space between ; then they pour out the honey pure and unmixed into these small reservoirs ; and how plentifully soever these magazines are filled, they take no rest till the time of labour and harvest is over. Thus do the Bees in summer, provide a sufficiency against the severity of winter : what wonderful wisdom appears in all the actions of these little creatures, what an example for man to guard against the winter of life.

Let us pass from the Bee to the Ant, which resembles it in many respects, except that the Bee enriches man, and the Ant strives all it can to impoverish him by stealing from him.

This little animal is informed, that the winter is long, and the ripe corn is not a great while exposed in the field : thus the ant never sleeps during harvest : it draws along with the little instruments which

are fixed to its head, grains of corn which are thrice as heavy as itself, and goes backward with them as well as is possible: sometimes it finds a friend by the way, which lends it assistance, but never waits for it. The repository (where all is public, and no one thinks of making a separate provision for itself,) is made up of several chambers, which communicate with each other by galleries, which are all dug so deep, that neither the winter rains or snows can penetrate so far, as to prejudice their stores. The subterraneous caverns of citadels are inventions by far more modern and less perfect, and those who have endeavoured to destroy the habitations of such ants as have had leisure to perfect them, have scarce ever succeeded; the branches of them are extended so far, that they do not feel all the injury that is offered them at first.

When their granaries are full, and the winter comes on, they begin to secure the grain by biting off the two ends of it, and thereby hindring it from growing: thus their first food is no other than a care for futurity, and what they are determined to rather by prudence than necessity. Hence we see what an incomprehensible fund of industry God has placed in this little animal: thus has he given it a kind of prophetic understanding, to oblige us to recur to him, to whom alone it belongs to work such prodigies.

Can we sufficiently admire the industry of certain animals, who spin with such art and delicacy, that all appears to be the effect of thought and a mathematical scheme? Who has taught the Spider, an animal, in other respects so contemptible, to form such fine threads so equal and so artfully suspended? who has learnt it to begin with fixing them to certain points, to join them all in one common centre, to draw them first in a right line, and then to strengthen them by circles exactly parallel? who has told it

that these threads should be a snare to catch other animals that have wings, and that it could not come at them but by this stratagem? who has appointed him his place in the centre, where all the lines meet, and where it is necessarily informed by the lightest motion, that some prey is fallen into its nets? Lastly, who has told him that his first care then should be to embarrass the wings of that imprudent prey, by new threads for fear it should still have left some liberty for disengaging and defending itself.

All the world is a witness of the labours of the Silk-worm: but have the most skilful artists hitherto been able to imitate them? have they found out the secret of drawing so fine a thread, so strong, so even, so bright and uniform? have they any materials of greater value than this thread for making the richest stuffs? do they know how the worm converts the juice of the leaf into golden threads? can they give a reason why a liquid matter, before it has taken air, should grow strong and lengthen itself in *infinitum*, as soon as it comes into it? can any of them explain how this worm is taught to form itself a retreat under the numberless turnings and windings of the silk, which have flowed from itself, and how in this rich grave it finds a kind of resurrection, which gives it the wings its first birth had refused it.

Every crawling worm becomes a kind of fly, gnat or butterfly; and first every fly has crawled in its original, and been a kind of worm, caterpillar or insect, before it had wings; and the middle state between these two extremes of elevation and meanness, is the time when the animal becomes a cod or bean, which is done a great number of ways, but always in a manner uniform to every species.

We shall next make some observations upon a small animal called the Formicalio: it is of an ugly figure, and looks as if it was but half finished: it is of a cruel disposition, for it lives only upon the blood

of its prey, and its sole occupation is to lay traps for it: its artifice is best seen by having such an animal in one's closet; put it into an earthen vessel full of very fine sand, in which it presently hides itself: when it is there it forms in the sand, the shape of a cone reversed, with an exact and geometrical proportion, and takes up its residence in the point of the cone, which is the centre of it; but still keeping itself covered.

If an ant or fly with its wings taken off, is placed at the entrance of the cone, this little animal, which one would not judge capable of the least effort, throws sand forcibly with its head upon the prey it has got intelligence of, in order to stun it and drag it down to the bottom, where it lies concealed; then he comes out from the place of his retreat, and after he has quenched his thirst, throws away the carcase, which might render his cruelty suspected. If one would have the pleasure of seeing him labour a second time, it is but filling up the cone by stirring the vessel; and it is surprizing to see with what diligence the little beast makes a new figure as large and regular as the former. How much reasoning is here required, if this workmanship was founded upon reason? can a mathematician think more curiously, and be better acquainted with the nature of the cone, of the sand, of the motions, and the conveyances of their sound from the centre to every part of the circumference? it is certain that this beast must reason or some one for it: but the wonder is not, either that it should reason, or a foreign principle reason for it, but that this principle should cause all this to be executed by organs which move of themselves, and seem to act only by an inward principle. Before we leave this subject, we must not omit mentioning, that this little ugly thing is transformed into a great and beautiful fly; and is no longer of the same sanguine humour, when it has cast off its first skin.

Those experienced in observations on the insect part of the creation, by the help of glasses have observed, that stagnated waters appearing green, red, or black, proceeds only from insects of several kinds and colours, nor is the earth, or air itself free from the seeds of life; but this may be better conceived by following the instructions given by Mr. BRADLEY, who, by the help of a microscope, has discovered an insect, which by computation he found more than a thousand times less than the least dust of sand visible to the naked eye: it is wonderful to discover the several parts of a creature so minute, how small must the organs of its senses be in proportion to its body! the eyes perhaps a thousand times less, and other parts answerable to them: but, alas! how trifling an object was the insect we have mentioned, in comparison to those discovered by Mr. LEWENHOECK, in a quantity of pepper water, no bigger than a grain of millet, in which he asserts to have seen ten thousand living creatures; and some of his friends at the same time, witness to have seen above thirty thousand creatures moving in that small quantity of water; nay, they tell us, that because they would be within compass, they only related half the number that they believed they had seen! Now from the greatness of the numbers mentioned, it is inferred, that in a full drop of water, there will be eight millions two hundred and eighty thousand of these animalcula; which, if their smallness comes to be compared, a grain of sand broken into eight million of parts, would not exceed the smallness of one of these insects.

Mr. HOOK tells us after he had discovered (by the assistance of good glasses) vast numbers of those animalcula described by Mr. LEWENHOECK, he made use of other lights and glasses, and magnified them to a very considerable size; and that amongst them he discovered many other sorts, much smaller than

than those he first saw ; some of which were so very minute, that millions of millions of them might be contained in one drop of water.

The ingenious Mr. RAY tells us of an insect which is hatched and dies in one day, and probably there are many other kinds, which as yet we know nothing of, whose life is of no longer duration : hence we may naturally reflect, that as we find by the help of a microscope, that quantity is only computed to be great or small, in proportion to what objects our eyes are capable of seeing without the assistance of glasses ; so the idea of time seems confined to our understanding by the same rule, and the life of that creature which lives only a day, may be of the same term or duration in proportion to itself, as the term of an hundred years is to mankind ; that is, three minutes of such an insect's life is equal to a year with us.

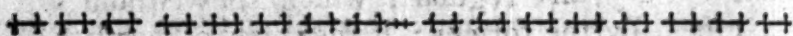
The term or duration of life, in different creatures is comparatively long or short according to the number, quickness, or slowness of ideas, presenting themselves successively to the mind : for when they succeed one another swiftly, and many of them are crowded into a narrow compass, the time, however short it may be, will seem long, in proportion to the number of ideas passing through it : on the contrary, when the ideas are but few, and follow one another very slowly, a long time will appear short, in proportion to their slow succession, and the smallness of their number. From these principles it is manifest, that one day may appear a thousand years, and a thousand years but as one day ; by which means the lives of all creatures may, for aught we know, seem to themselves nearly of the same duration. The Ephemeron is an unusual and special instance of the brevity of life in some insects ; the life of the said little creature is about six hours, in that time it performs all the necessary offices of life : nearly in the beginning thereof it sheds its coat ; and that being done, and the poor little animal thereby rendered light and

agile, it spends the rest of its time in frisking over the waters. The female droppeth her eggs on the the waters, and the male his sperm on them, to impregnate them; these eggs are spread about by the waters, descend to the bottom by their own weight and are hatched by the warmth of the sun into little worms, which make themselves cases in the clay, and feed on the same without any need of parental care.

Innumerable are the instances of the great care insects take of their young: thus all of them which do not themselves feed their little race, still take care to lay their eggs in such places as are most convenient for their exclusion, and where, when hatched, their proper food is ready for them: so for example, we see two sorts of Butterflies fastening their eggs to cabbage leaves, because they are fit aliment for the Caterpillars that come of them; whereas should they fix them to the leaves of a plant improper for their food, such Caterpillars must need be lost, they chusing rather to die than taste of such plants; for that kind of insect hath a nice and delicate palate, some of them feeding only upon a particular species of plants, others on divers sorts, but those of the same nature and quality utterly refusing them of a contrary kind; whereas should they scatter them carelessly and indifferently in any place, the greatest part of the young would in all likelihood perish soon after their exclusion, for want of food; and so their numbers continually decreasing, the whole species in a few years would be in danger of being lost: whereas no such thing we dare say, hath happened since the first creation.

So we see, according to the usual course of nature, Lambs, Kids, and many other creatures are brought forth in the spring of the year; when tender grass, and other nutritive plants, are provided for their food. Instance the Silkworm, whose eggs are hatch-

ed when the mulberry trees begin to bud and put forth their leaves, whereon these precious insects are to feed ; these and many other proofs might be produced to shew the wisdom of the Deity, and his particular regard for the minutest part of the creation ; but as the subjects here to be treated on are numerous, we shall next endeavour to shew many marks of God's stupendous power in the wonderful properties of earth, air, light, water, &c. &c.



С Н А Р. X.

Of the TERRAQUEOUS GLOBE.

LET us take a view of this principal fabric, which is a most stupendous work; and every particular part thereof doth aggrandize the power of the Deity. Let us ransack all the globe, and with the greatest accuracy, inspect every part thereof, search out the inmost secrets of any of the creatures; examine with our most curious gauges, measure by the nicest rules, pry into them with our microscopes; and we shall find that they bear testimony to their Infinite Artist, as they far exceed the most exquisite workmanship of the ingenious and best astronomers, mathematicians and mechanics, the world ever produced. The works of art, when examined by the best of glasses, appear rude and bungling pieces; but the closer we inspect into those of the Creator, the more we admire them. By the most diligent researches of ingenious men, it appears this globe of earth is nearly spherical, which is allowed to be the most commodious figure on many accounts;

as it is most capacious, as its surface is equi-distant from the centre not only of the globe, but at least (nearly) of gravity and motion. This figure is the most proper in regard of heat, and of light also in some measure; for by this means, those two great benefits are uniformly and equally imparted to the world; they come harmoniously and gradually on, and go off in the same manner, so that the daily and yearly returns of light and darkness, cold and heat, moist and dry, are regular; which they would not be, especially the former, if the mass of earth and waters were, as some imagined it, a large plain; or as others, a great hill in the midst of the ocean; or of a multangular figure. This form of the earth is admirably adapted to the commodious and equal distribution of the waters in the globe; for since by the laws of gravity, the waters will possess the lowest place; therefore, if this mass of earth was cubic, prismatic, or any angular figure it would follow, that a large part would be drowned; and another be too dry: but being thus orbicular, the waters are here and there as the Divine Providence saw most fit. For a more copious account of the watery element see the subject on Water.

The orbicular figure of our globe is far the most beneficial to the winds and motions of the atmosphere: it is not to be doubted, if the earth was of any other form, the current of air would be much retarded, if not wholly stopped. We find by experience, what influence large and high mountains, bays, capes, and headlands have upon the winds; how they stop some, retard many, and divert and change near the shores, even the general and constant winds that blow round the globe in the torrid zone: therefore since this is the effect of such little excrescences, which have but little proportion to the whole mass, what would be the consequences of much greater angles, that would equal a quarter,

tenth, or but a hundred part of the globe's radius ? certainly these must be such a barricade, as would greatly annoy, or rather absolutely stop, the currents of the atmosphere, and thereby deprive the world of those salutiferous gales that keep it sweet and clean, For the size of this globe we refer the reader to our remarks on Astronomy.

How amazing it is that that this earth rests upon nothing, but is pendent, and hangs in the air without any visible cause to uphold it from above or support from beneath ; and that it should fly through the regions of air with such velocity, and yet preserve a due and proper distance from that great fountain of light and heat the sun !

What a prodigious number, and how great a variety of beasts, birds, insects, reptiles, fishes, vegetables, minerals, metals, and fossils, does the earth produce ; that there is nothing wanting, either for food, physic, cloathing, or building ! the munificence of the Creator is so great, that there is amply sufficient to supply the wants, yea almost all the extravagancies of all the creatures upon this terraqueous globe.

The various soils, moulds and strata or beds of earth, manifest in a particular manner, the power, wisdom, and goodness of God, in making such astonishing provision for the good of the creation : for as many trees, plants, and grains dwindle and die in a disagreeable soil, yet thrive and flourish in others ; for instance different plants delight in the following soils, warm, cold, lax and sandy, heavy or clayey, mixture of both, wet and dry places ; still we find provision enough for all these purposes : every country abounding with its proper trees and plants, every vegetable flourishing and gay, somewhere or other about the globe. To this convenience we may add the great use and benefit the various soils are to different animals, who make in the earth their places of repose, retreat in winter, security from any ene-

mies, and nests for their young : some delight in a lax, pervious mould, admitting them an easy passage ; others delight in a firmer and more solid earth, that will better secure them against injuries from without.

The various strata or beds, although but little different from the soil or moulds, yet will deserve a distinct consideration : we mean those layers of minerals, metals, earth and stone, lying under that upper stratum or tegument of the earth last spoken of, all of prodigious use to mankind ; for building, ornament, furnishing us with machines ; tools, vessels, and a multitude of other uses ; particularly in physic, exchange, commerce, in manuring and fertilizing our lands, in dying, colouring, and a thousand other things, too many to be here inserted : but there is one grand use of these strata, or beds, that cannot easily be omitted, that is, those subterraneous strata of sand, gravel, and laxer earth that admit of, and facilitate the passage of the sweet waters, may probably be the colanders whereby they are sweetned, and then at the same time also be conveyed to all parts of the habitable world, not only through the temperate and torrid-zones, but even the farthest regions of the frozen poles. That these strata are the principal passages of the sweet fountain of waters, is not to be doubted, considering that in them the waters are well known to pass, and where the springs are found ; we mean the principal passages, because there are other subterraneous channels, through which many times the waters make their way. As subterraneous caverns and volcanos are by some objected against, as being pernicious to community, and looked upon as a fault in the structure of the globe, we shall briefly take notice that they have their uses, being as spiracles or tunnels to the countries where they are ; to vent the fires and vapours that would make dismal havoc, and oftentimes actually do so,

by dreadful succussions and convulsions of the earth: nay, if the hypothesis of a central fire and waters be true, these outlets seem to be of the greatest use to the peace and quiet of the terraqueous globe, in venting the subterraneous heat and vapours; which, if pent up, would make dreadful and dangerous commotions of the earth and waters. It may be accounted as a special favour of Divine Providence, that there are scarcely any countries, that are much annoyed with earthquakes, that have not one of these fiery vents: and they are constantly all in flames when ever any earthquake happens, they disgorging that fire which whilst underneath, was the cause of the disaster. Were it not for these diverticula, whereby it thus gained an exit, it would rage in the bowels of the earth much more furiously, and make greater havock than it now doth; so that, though those countries, where there are such volcanos, are usually more or less troubled with earthquakes; yet, was they wanting, such parts would be much more annoyed with them than at present; in all probability to that degree, as to render the earth for a vast space round, perfectly uninhabitable. So beneficial are volcanos to the territories where they are, that there doth not want instances of some which have been rescued, and wholly delivered from earthquakes by the breaking forth of a new eruption; this continually discharging that matter, which till then had been imprisoned in the bowels of the earth, was the occasion of very great and frequent calamities.

The last thing we shall take notice of relating to the earth, is the noble, useful, and necessary appendages of the globe both mountains and valleys. As to the business of ornament, beauty, and pleasure, we may appeal to all men's senses, whether the grateful variety of hills and dales, be not more pleasing than the largest continued plains: let those who make it their business to visit the globe, to divert

their sight with the various prospects of the earth ; let these, I say, judge whether the far distant parts thereof would be worth visiting if it was every where of an even level, a globous surface, or one large plain of a thousand miles ; and not rather as it now is ; whether it be not more pleasing to the eye, to view from the tops of the mountains the subjacent vales and streams, the far distant hills ; and again from the vales to behold the surrounding mountains ? The elegant strains and lofty flights, both of the ancient and modern poets on the occasion, are testimonies of the sense of mankind on this configuration of the earth : but be the case as it will as to beauty, which is the least valuable consideration, we shall find as to convenience, this form is far the most commodious on several accounts.

First, As it is the most salubrious and of the greatest use to the preservation or restoration of the health of man. Some constitutions are indeed of so happy a strength, and so confirmed a health, as to be indifferent to almost any place or temperature of the air : but others are so weakly and feeble, as not to be able to bear one ; but can live comfortably in another place. As the finer and more subtle air of the hills do best agree with those who are languishing and dying in the feculent and grosser air of great towns, or even of the warmer and more vapourous air, which the valleys contain ; so on the contrary, others languish on the hills and grow lusty and strong in the warmer air of the valleys.

Secondly, To this salutary conformation of the earth, we may add another great convenience of the hills, and that is in affording commodious places for habitation ; serving as skreens to keep off the cold, nipping blasts of the northerly and easterly winds ; also reflecting the benign, cherishing sun beams, so rendering our habitations more comfortable in winter ; and promoting the growth of herbs and fruits in summer.

Thirdly, Another benefit of the hills is, that they serve for the production of a great variety of different species of vegetables, because of the great diversity of soils that are found there, every vertex or eminence almost affording new kinds. Now these plants serve partly for the food and sustenance of such animals as frequent the mountains, partly for medicinal uses; the chief, physic, herbs, and roots, the best in their kinds growing there; it being remarkable, that the greatest and most luxurious species in most genera of plants are natives thereof.

Fourthly, The mountains serve for the harbour, entertainment, and maintenance of various animals, birds, beasts, and insects that breed, feed, and frequent there. The highest tops and pikes of the *Alps* are not destitute of their inhabitants, the Ibex or Stein Buck among quadrupeds, the Lagopus among birds, the Papilioes and store of other insects: nay the highest ridges of them serve for the maintenance of cattle for the service of the inhabitants of the valleys.

Fifthly, Those long ridges and chains of lofty mountains, which run through whole continents east and west, serve to stop the evagation of the vapours to the north and south in hot countries, condensing them like atombic heads into water, and so by a kind of external distillation giving the original to springs and rivers; likewise by amassing, cooling, and condensing, turn them into rain, by those means rendering the fervid regions of the torrid zone habitable. The hills serve for the generation of minerals and metals, and in them principally are the most useful fossils found; or if not so, yet at least all these subterraneous treasures are more easily come at than in the vales.

Sixthly, That it is to the hills that the fountains owe their rise, and the rivers a conveyance, is beyond dispute; but be the modes, or the method Nature takes in this great work as it will, it is sufficient

to our purpose, that the hills are a grand agent in this so noble and necessary performance : and consequently that those vast masses and lofty piles, are not (as charged by some) rude and useless excrescences of our ill-formed globe; but the admirable tools of nature, contrived and ordered by the infinite Creator, to one of its most useful works, and to dispense this great blessing to all parts of the earth ; without which neither animals could live, nor vegetables scarcely grow, perhaps minerals, metals, or fossils, not receive any increase. For was the surface of the earth even and level, and the middle parts of islands and continents not mountainous and high, as now they are, it is most certain there could be no descent for the rivers, no conveyance for the waters; but instead of gliding along those gentle declivities which the higher lands now afford them quietly down to the sea, they would stagnate, and perhaps drown large tracts of land.

Thus having vindicated the present form and fabric of the earth, as distributed into mountains and valleys, and thereby shewn the usefulness thereof, (which some have found fault with,) we hope we have made it in some measure evident that God was no idle spectator, nor unconcerned in the ordering of this terraqueous globe, (as some wicked men have inferred) but that there is a great display of the wisdom, power, and goodness of the Eternal, in the formation of this grand beautiful globe of earth; so excellently contrived for every purpose of the creation, but particularly for the profit, pleasure, and happiness of man. There is such harmony throughout the creation, that if we will but pursue the ways of piety and virtue, which God has appointed; if we will form our lives according to the Creator's laws, we may escape many evils in this our frail state, and by the interposition of our Mediator, be prepared for a happy exit to the blissful regions of eternity.

Gravity.

The last thing we shall take notice of that is subservient to our globe, is gravity, or that tendency which all bodies have to the centre of the earth: that there is such a thing, is manifest from its effects here upon earth; and that the heavenly bodies attract or gravitate to one another, when placed at due distances, is made highly probable by Sir ISAAC NEWTON. This attractive or gravitating power we take to be congenial to matter, and imprinted on all the matter of the universe, by the Creator's fiat at the creation.

This attraction or gravity, as its force is in a certain proportion, so makes the descent of bodies to be at a certain rate; and was it not for the resistance of the medium, all bodies would descend to the earth with the same velocity; the lightest down as swift as the heaviest mineral; as is manifest in the air-pump, in which the lightest feather, dust or a piece of lead, drop down in the same time, from the top to the bottom of a tall exhausted receiver. As a proof of what absolute use this contrivance of gravity is for keeping the several globes of the universe from shattering to pieces (as they evidently must do in a little time, by their swift motion round their own axis, if it was not that all bodies gravitate to their centre) most fluids preserve a spherical figure, quicksilver manifestly doth, especially in small drops or quantities; in which case their own self-attracting power, is equal to, or exceeds that of the earth; so doth lead, and other metals, when properly run into water that is of a due temper, as may be seen in the making of shot: so doth water, oil, and other liquids run into a spherical form when hung on a small surface, as at the point of a pin: or into a hemispherical figure, on a broader surface; their

self-attraction causing the former, as that of the earth, and the surface on which they lie, doth the latter. Lastly, to come to the more evident benefit we receive from gravity, please to observe, that all bodies have a natural tendency to the centre of our globe; for whatsoever the decays are among earthly things, however their forms are changed, yet their matter remaineth entire, and returneth again to its grand parent the earth; so by this power all its parts are kept in their proper place and order: all material things do naturally gravitate thereto, and unite themselves and so preserve its bulk entire; the fleeting waters, the most unruly of all its parts, do by this means keep their constant equipoise in the globe: so that by virtue of this excellent contrivance of the Creator, the observation of the Psalmist is perpetually fulfilled, (PSAL. lxxxix. v. 9.) Thou rulest the raging of the sea; when the waves thereof arise, Thou stillest them.

A general View of the Vegetable Creation.

Was a man introduced into the world at once with all the powers and faculties of his soul in full vigour and perfection, how would he be astonished in surveying the magnificent scene of things before him! the earth, the air, the sea, the azure vault of heaven, the almost infinite variety of plants and animals, the glorious regent of the day bountifully dispensing the light and heat to all around, the silver queen of night, and all the host of heaven passing nightly in review before him! but how would his admiration rise, if he should further be made acquainted with the discoveries of the telescope, mi-

croſcope, and priſm ; but as the microſcope alone is eſſential to the ſubject in queſtion, pleaſe to obſerve, that by the aſſiſtance of a good one, we may diſcover the greateſt beauties in the ſmalleſt ſeeds, but particularly the acorn, which diſplays a foreſt in miniature : view but the meaneſt flower of the field, and compare therewith ſilks of the moſt exquisite workmanſhip ! how coarſe are the latter in comparison ! how groſs is the workmanſhip ! what a multitude of herbs, trees, fruits and flowers, does the earth bring forth ! how delightfully various in their kinds ! ſo that we are never ſatiated with ſeeing or taſting them ; how exquisitely delicious are ſome ! how lovely beautiful are others ! how infinitely uſeful all ! how amazing it is, that the ſame earth ſhould produce ſo many kinds, quite different from each other both in ſhape, colour, and properties ! Obſerve how finely variegated is the tulip ! what a fine yellow, and what a moſt delicate ſmell has the cowſlip ! what painter can equal the bluthing roſe ? what perfumer equal it in ſmell ? it no ſooner opens, but it has all its freſhneſs and luſtre ; has art invented ſuch lively, and at the ſame time ſuch delicate hues ? If we were to examine the wiſdom of God in the compoſition of a flower, one could but imagine it was to laſt forever ; but before the evening it ſhall fade, the next day withered by the ſun and perished.

Next let us conſider the general colour wherewith it has pleaſed God to beautify every plant : if the fields had been clothed in white or red, who could have borne the ſplendour or rigour of their dreſs ? if he had blacken'd them with darker colours, who could have been delighted with ſo ſad and mournful a ſpectacle ! an agreeable verdure holds the mean between the two extremes, and bears ſuch relation to the ſtructure of the eye, that it reſreſhes inſtead of tiring it, and ſupports and nourishes it, inſtead of exhausting its force ; but what at firſt we ſhould judge to be one colour, is an aſtoniſhing variety of

shades ; it is every where green, but no where the same : no plant is coloured like another ; and this surprizing variety, which no art can equal, is further diversified in every plant, which in its birth coming forth, in its growth and maturity, puts on a different verdure : the same may be said of the figure, smell, taste, and uses of plants, both for nourishment and medicine. We shall make here but one more reflection on this head of the subject : if God had not given us hay, which when dried would keep for a long season, the power of feeding cattle in the winter would have been impossible ; these very dry herbs suffice likewise to make other animals give milk, and particularly the cow twice a day, which may supply the place of all other food to a whole family.

Hitherto we have considered the earth as a field or garden of herbs ; let us now consider it as a rich orchard abounding with all kinds of fruit, which succeed one another according to the seasons : let us consider one of these trees extending its branches, and bowing down under the weight of excellent fruit, whose colour and smell invite the taste, and in surprizing plenty. Such invitations as these we seem to hear from every quarter, and as we advance, we still discover new subject of praise and admiration : here the fruit lies concealed within ; and there the kernel is covered with a delicate pulp, all shining without in the most lively colours : this fruit arises from a flower, as almost all fruits do ; but that others which is so delicious is preceded by no flower, but springs out of the very rind of the fig tree : this one begins the summer, and that other ends it : if one is not speedily gathered, it falls and withers ; and if time is not allowed to another, it will never come to maturity. It is observed, that weak trees, or those of a moderate height, bear the most exquisite fruits ; the higher they rise, the poorer they appear, and they are less agreeable in flavour : from whence we may learn an useful lesson ; and the feeble stem of

the vine tells us in its language, that the most wonderful fruits are often the humblest. The other trees which bear only leaves, or fruits that are bitter and very small, are notwithstanding very useful; and Providence has made up the defect in such a manner, that upon some occasions the barren are to be preferred to the more fruitful, which are hardly of any use, either for building or navigation, or other indispensable wants: for instance behold the trees of the forest, how different their green, how valuable the timber; how lofty and majestic is the cedar, how noble and useful the oak, whose stubborn nature defies stern winter's furious blasts. Lastly, among the trees, we observe some which always preserve their verdure, and in them we may discern a figure of immortality, as the others which are stripped in the winter to be cloathed again in the spring, seem to remind us of the mortality of our bodies, and presents to us an image of the resurrection.

C H A P. X.

The Properties of AIR.

WHEN we have considered how necessary air is to our existence, and the many great advantages the creation in general receive from the said element, we hope such considerations will vindicate how necessary an explanation of its wonderful properties may be to many, who have not as yet once reflected on the benefit and indispensable necessity there was for air at the creation of this globe: it is this, however common, and little notice taken of,

that maintains the life, the health, the comfort, the pleasure and business of the whole earth : it is this the whole animal world breatheth and liveth by : not only the animals inhabiting the earth and air, but those of the waters too ; and not only animals, but even trees and plants, and the whole vegetable race, all owe their life to this useful element : without it most animals can scarce live half a minute, and others that are most accustomed to the want of it, cannot live without it many days. That this is fact, is proved to ocular demonstration, by a machine called an air-pump, which having a bell glass (called a receiver) placed over the top of it, by the working of the pump, near all the air is drawn or taken away from that part which is under the glass.

The ingenious Mr. DERHAM, by repeated experiments which he made with the air-pump, found that animals whose hearts have two ventricles, and no *foramen ovale*, as birds, dogs, cats, rats, mice, &c. die in less than half a minute, counting from the very first exsuction, especially in a small receiver. A mole (which he suspected might have borne more than other quadrupeds) died in one minute, without recovery, in a large receiver, and doubtless would hardly have survived half a minute in a small receiver. A bat (although wounded) sustained the pump two minutes, and revived upon the re-admission of the air ; after that he remained four minutes and a half, and revived : lastly, after he had been five minutes, he continued gasping for a time, and after twenty minutes the air was re-admitted, but the bat never revived. As for insects, wasps, bees, hornets, grasshoppers, and lady-cows, seemed dead in appearance in two minutes ; but revived in the open air in two or three hours time, notwithstanding they had been in *vacuo* twenty-four hours. The ear-wig, the great staphylinus, the great lousy beetle, and some other insects, would seem unconcerned at the vacu-

um a good while, and lie as dead, but revive in the air, although some had lain sixteen hours in the exhausted receiver.

Snails bear the air-pump prodigiously, especially those in shells; two of which lay above twenty-four hours, and seemed not much affected: the same snails he left in twenty-eight hours more after a second exhaustion, and found one of them quite dead, but the other revived. Frogs and toads bear the pump long, especially the former: a large toad, found in a house, died irrecoverably in less than six hours: another toad and frog were put in together, and the toad was seemingly dead in two hours, but the frog remained just alive; after they had remained there eleven hours, and seemingly dead, the frog recovered in the open air, only weak; but the toad was quite dead: the same frog being put in again for twenty-seven hours, was then quite dead.

The animalcules in pepper-water remained in *vacuo* twenty-four hours: and after they had been exposed a day or two in open air, he found some dead, some alive.

That the air is the principal cause of the vegetation of plants, is likewise proved by the same engine. Some lettuce seed being sown upon some earth in the open air, and some of the same seed at the same time upon other earth, in the glass receiver of the pneumatic engine, afterwards exhausted of the air: the seed exposed to the air was grown up an inch and a half high in eight days; but that in the exhausted receiver not at all; and air being again admitted into the same emptied receiver, to see whether any of the seed would then come up, it was found that in the space of one week it was grown up to the height of two or three inches.

Thus absolutely necessary is the air for the sustenance of all things; but it was not only necessary that air should be, but that it should be just of a proper consistence; for had the air been either much

thicker or thinner than it is, it would have been as fatal to the whole living world, as the entire want of it: for if thicker we could not have lived is evident from experience; for if we are confined in a close place, the air being rendered thicker therein by the exhalations of our bodies, it soon becomes unfit for use, we pant and grow faint, and if not relieved, should at last die, as has been proved by experiments on many animals.

Mr. DERHAM close shut up a sparrow, so that no fresh air could get in, in less than an hour the bird begun to pant, and be concerned; in half an hour more to be sick, vomit, and more out of breath, and in two hours from his first confinement to be nearly expiring.

Suppose the air had been thinner, it would not have been so fit for respiration, as the common air, as for instance, the learned Joseph Acosta gives a relation of himself and his company, that when they passed the high mountains of *Peru*, which they called *Periocaca*, he and his companions were surprized with such extreme pangs of straining and vomiting, not without casting up blood too) and with so violent a distemper, that he concludes he should undoubtedly have died, but that this lasted not above three or four hours, before they came into a more natural temperature of air. Many other circumstances might be produced to prove that the higher you ascend into the atmosphere the lighter the air. It also appears that it is necessary to life that air should have some weight; as its height reaches about forty-four miles, the whole weight of air that lies on every superficial square foot of earth, is above two thousand pounds; so that the pressure of the whole atmosphere, on the superficies of the whole earth, is equal to a weight of almost five thousand millions of millions of tons; and the weight of the air pressing on the body of a man of six foot stature, is equal to twenty-eight thousand pounds. How is it then, that

we constantly support so enormous a weight? what wonderful power is it that preserves men, beasts, houses, &c. from being crushed to pieces? it was the Omnipotent that balanced this weight of air by the equilibrium of an internal air, which is placed within all bodies; which, though it be but small, yet can balance, resist, and equiponderate the intolerable weight of external air: how amazing that that little quantity within our bodies, which we are continually breathing in and out, is able to counter-balance the vast weight of twenty-eight thousand pounds! by which means we are rendered quite insensible of so immense a weight, and move about as if we had no pressure at all upon us; for the spring or force of the internal air, with which our bodies are filled throughout, by being every way equal to that of the external air, and consequently forcing with as great a pressure outwardly, as the external air does to press us together; it naturally follows, that we cannot be sensible of either, because they are both equal; just as two equal weights put into the scales though ever so large, will not have any effect, but add one grain to either, and that will sink down and the other rise: and this is exactly the case of the external and internal air; for if the pressure of either is taken away, the other acts with a most amazing force. Thus it appears by experiment, that if the internal air is extracted from any animal, the external will squeeze the animal flat and press it to death. By a flat empty bottle laid on its side, it will appear evidently that it is the internal air whether it be stopped or not, that counter-balances the external pressure of the air, and thereby keeps the bottle from being broke; for by applying a syringe to the mouth of the bottle, and pumping out that internal air which is in the bottle, no sooner is this fully done, but the pressure of the external air immediately breaks the bottle into a thousand pieces. Thus a globe, or hollow ball of brass, being divided exactly

into two equal parts, and the edges made smooth, will, upon being put together, without any manner of cement, and the air within them being drawn out by means of a cock, the outward air will press them so close together, that it will require a fifteen pound weight for every square inch their circumference contains, to pull them asunder: no less powerful is the internal air in bodies; when the external is taken away, it has been found that it will by the bare force of its spring, dilate itself into thirteen thousand times the space it possessed under the pressure of the external air. If a strong glass bottle closely sealed up, is put under the receiver of an air-pump, the air being drawn out from that part which is covered by the receiver, the air within the bottle will expand itself with so much force, as to break the bottle into a thousand pieces. There have often been instances of men and cattle being killed by lightning, without the least visible mark of damage being done to the body or bodies: this is supposed to be occasioned by the lightning's rarifying or taking off the pressure of the external air so much, that the air within their bodies expands or dilates itself with such force, as to burst all the blood vessels, &c. whereby immediate death is occasioned, without any outward signs of injury.

We find that wood, steel, and every other elastic body that we know of, by being kept long bent or pressed together, lose its spring or elastic force, or at least have it lessened; but the same spring of the air being so absolutely necessary to the world at all times, God has so endued it, that its spring is not lost or lessened, let it remain compressed ever so long.

Mr. DE ROBERVAL, of the Academy Royal of Sciences, having let his air-gun remain charged with condensed air sixteen years, found on discharging his gun, that the air's spring or elastic force was not at all abated, but produced the same effect as at first. There have been a great number of curious and entertaining experiments made, to prove even to the

eye this natural or inherent spring of the air; but as the subject on air is a copious one, we shall leave the reader to judge whether what has been advanced on the elasticity of the air, be reasonable or not; which he may prove by a variety of simple experiments.

Every property of the air affords fresh matter of astonishment; for though the air is a sufficient body to act so powerfully, as to expand itself into thirteen thousand times the space; though it is continually acting upon us, and we are on all sides surrounded by it, yet it is still invisible to our eyes; for had it been visible, how many delightful pleasures should we have been deprived of, and how many inconveniences should we have suffered by it? in vain then had been the ravishing landscapes of hills and vales, groves and fields; in vain would enchanting beauty sit smiling on the human face, had the air been made visible; for we should not then have been able to have discerned objects through it, with any degree of clearness and distinction; but should have seen all the bodies that surround us in a very obscure and confused manner: was the air discernable like other bodies, the vapours would be still more so, the least smoke would disfigure the beautiful landscape of nature: life itself would become painful and uneasy; we should see the humours that are perpetually sent out by perspiration from the bodies of animals, all the unctuous vapours, all the filth and nastiness that exhales from our kitchens, our streets and common sewers: society would be rendered insupportable, and we should seek for health and safety in our solitudes, flying to woods and deserts to escape the dangers that seem to threaten us, or to get out of the way of those nuisances which would be the inevitable consequences of such a sight. Were all the impure, nauseous, unwholesome particles in the air, which we are continually breathing into our lungs, visible to our eyes, in what continu-

al fear should we live, of being poisoned by them! but by the air being invisible, we are released from the incessant cares and fears of drawing into the lungs, by the mouth and windpipe, such things as would appear quite loathsome for us to do: but nevertheless, lest those exhalations which cease to be offensive and hurtful to us when dispersed, should, by being invisible, insensibly gather and thicken, so as to suffocate and injure us, we are forewarned of the danger by the sense of smelling, and rescued from it, by the current of the winds.

There is no less matter for wonder and gratitude, in us, then, though the air is composed of so many millions of particles, exhaled from every thing, that it should acquire no manner of taste, to make our palate in the smallest degree sensible of it! how highly loathsome would it have been, had we in drawing our breath, tasted the nauseous particles that arise from corrupted bodies, &c.

It is worth our reflection that, though the air is a fluid, or of a liquid nature, and has all the properties of one, yet it cannot, by the most excessive cold, be congealed or frozen like water: was it in any manner capable of this, it would be fatal to every creature on earth: what a manifest instance is it then of design and contrivance, that though it has every other property of a fluid, yet it should be without this one! Besides the many other uses of the air, it is absolutely necessary to fire and flame; for a candle or live coal will instantly go out under the glass of the air-pump, as soon as ever the air is pumped out. That fire is fed by the air, and that the air's essential matter, or vivifying spirit, may be consumed by fire, is evident; because no creature will live nor a candle burn in air which has passed through the fire, and may be called burnt air: to this is owing the sad effects which have often happened by burning charcoal in a close room, where there is no chimney; for while fresh air comes freely in, to supply the

place of that which has been burnt by the charcoal, no ill effects arise from it; but fire soon consumes the vivifying spirit of the air within the room, so as to render it unfit for life, as has been too often fatally experienced. If the glass of an air-pump is exhausted of the air within it, and the air let in again through a charcoal fire, a candle instantly goes out, if within the glass.

It is owing to the air that we enjoy the light in the manner we do, for was it not that the rays of the sun are reflected back to our eyes from every part, by the particles of the air, the heavens by day would have the appearance of night: the sun indeed, would appear a great light in that part of the dark firmament where it was; but then, whenever we turned our back on it, we should see all night and darkness surround us, even at noon tide. That whiteness or lightness which appears to our eyes in the sky all around, in the day-time, is owing to the air; and was the air away, it would never be so: but the air has not only the power of reflecting the rays of the sun, but likewise of refracting them, or turning them out of a direct line, and bending them toward the earth; so that those rays which would by their course pass directly through the sky, and be of no service to us, are, by this power of the air, turned toward the earth: and it is by this means we enjoy a considerable degree of light before the sun rises, and after he sets, which we call twilight, this being occasioned by this wonderful property of the air; before the sun rises or sets, the rays of light darting upward, would pass in a straight line through the atmosphere, and not be discerned by us, and consequently be of no manner of use to us; but being turned out of their direct course by this power of the air, they are bent toward the earth, and brought to our eyes. Was it not for this, the moment the sun set, we should be in total darkness, and a cloudy night would then present us with the black-

est darkness possible : and still more injurious to us would the rising of the sun be ; for if, after the pitchy darkness of the night, the day was to break in suddenly upon us, in the full strength and power of its brightness, the tender organs of sight would not be able to endure such excessive splendor, but be overpowered by the violence of the shock ; whereas gradual increase of light, does insensibly strengthen the eyes, and prepare them for the reception of a greater degree of lustre ; this twilight inures them to bear the morning sun, and this again fortifies them against the more powerful beams of it, when shining in its full meridian glory : so great is the benefit we receive from this property of the air, that through its means we actually see the sun itself at sometimes of the year, taking morning and evening together, ten minutes longer than we should otherwise do : at a medium, it is six minutes each day throughout the year, which makes three days in one year ; so much longer do we enjoy the sun, than we could otherwise do.

By the gravity of the air, it is that water in reservoirs is forced to enter the conduit pipes, and is thereby carried to any conduit, house, or other place below the horizontal level of the surface of water in the reservoir, or fountain, be the distance what it will. Another effect of the air's gravity we shall here mention, is the most important of all, as being the immediate instrument of life ; we mean the acts of inspiration and expiration in animals ; for in the dilation of the thorax, the air, by the pressure of the atmosphere, is forced into the cavity of the lungs, which we are then said to breathe in, or inspire ; but when the muscles contract, the air is expelled, and we are then said to breathe it out, or expire it ; and this alternate action of the lungs is maintained by the air's pressure, and is absolutely necessary to life.

It is likewise owing to this property of the air, that infants can receive their food from their mother's breasts; for the child in sucking, drawing away the air from about the orifice of the nipple, the air pressing upon the surface of the breast, forces the milk to spring out plentifully, as there is nothing there to resist it, the continual suction of the child taking away the pressure of the air from off that part: that this is the case, is plain, otherwise the sucking of the child could never make the milk to come; and it is the same with all other creatures that do suck.

Many other benefits do we receive from the air, such as the winds, which are so necessary for sailing to different parts of the globe.

To those who were not before acquainted with the surprizing properties of air, have we opened a scene of amazing knowledge of the wonderful things of nature, the prospect of which was laid open to us for the noblest purposes, to make us better men, and to fill our hearts with the most exalted sentiments of love and gratitude towards him, who is the giver of all good things.

Light.

There is still another appendage of our habitation, which is no less common, no less headed, and yet no less useful than the air itself, and that is light: for what benefit would life be of, what pleasure, what comfort would it be for us to live in perpetual darkness? how could we provide ourselves with food and necessaries? how could we go about the least business, correspond one with another, or be of any use in the world, or any creatures be the same to us without light, and those admirable organs of the body, which the great creator hath adapted to the perception of that great benefit? but now, by the help

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of this admirable, this first made (because most necessary) creature of God; by this we find, all the animal world is enabled to go as their occasions call; they can with admiration and pleasure behold the glorious works of God; they can view the glories of the heavens, and see the beauties of the flowery fields, the gay attire of the feathered tribe, the exquisite garniture of many quadrupeds, insects, and other creatures; they can take in the delightful landkips of divers countries and places; and behold the harmony of this lower world, and of all the globes above. Men, whose business and occasions oftentimes necessitate them to borrow a part of the night, and all other animals, particularly such whose safety, temper or constitution of parts (as of their eyes for instance,) confine them to their dens and places of retirement and rest by day, and are therefore in course compelled to seek their food, and wander about on their most necessary occasions of life by night: all these would at once be cut off from one of the grand benefits of life, from acting that part they bear in the creation, during such time as they should be put into absolute darkness. It may seem that light is a necessary consequence of the sun, or any other luminous body, and that there needed only these to give light to the world; but as the same all-seeing and unerring wisdom was as necessary to endue it with just such properties as would render it of use to us, as there was to form the air of just such a proper consistence, as rendered it fit for our breathing in, and no other; in vain might the sun have emitted light had not the wisdom of God disposed it to pass or fly with a most amazing and inconceivable swiftness: had not this been so ordered, the sun being placed in the heavens would have been but of little service to us, his rising every day would have cherished us very little, either with its light or heat; for was the motion thereof no swifter than the

motion of the swiftest bodies on earth, such as a bullet out of a great gun, (which flies a mile in about eight seconds and a half of time) or of sound which flies a mile in about four seconds and a half, light would take up in its progress from the sun to us, thirty-two years, at the rate of the latter motion; so that in this case, its vigour would be greatly cooled and abated; its rays would be less penetrating, and darkness would be with great difficulty dissipated: but light passing with the prodigious swiftness of almost two hundred thousand English miles in one second of a minute, or being but about seven or eight minutes of an hour in coming from the sun to us, which is above eighty-six millions of miles, therefore we receive the kindly effects and influences of that noble and useful instrument of our advantage, undiminished by its long passage. How amazing is this wonderful swiftness! we esteem a ball shot out of the mouth of a cannon to fly with prodigious celerity, but light flies a million of times faster; and it not only flies thus amazingly swift, but it reaches to an inconceivable distance, even to the farthest bounds of the universe; which is so vast, that it exceeds the comprehension of man's understanding: but that it is of this extent is manifest from our seeing some of the farthest distant objects, the heavenly bodies, some with our naked eye, some with the help of glasses, and others in all probability farther still with better glasses.

Now as light is of the greatest use to enable us to see objects at all, so the extension thereof is no less useful to enable us to see afar off: by which means we are afforded a sight of many illustrious orbs visible in the heavens, and can improve them to some of the noblest sciences, such as navigation and astronomy: but there was still further wisdom employed in the formation of light; for as it was necessary it should pass with such a prodigious swiftness, had not its particles been formed extremely small, it would

have beaten in pieces all solid bodies ; for we know that the force with which any thing acts, is encreased in proportion to the swiftness with which it moves. Thus a bullet, that perhaps does not weigh much above an ounce, will, by the swiftness it moves with when shot out of a musket, pierce through and beat in pieces exceeding strong and solid bodies, which it would have no effect on, was it to be flung against them with the hand only : and it is certain, that with the swiftness with which light flies, a particle of it weighing but the eighteenth part of a grain only would act with as great force upon any body, as a ball of twelve pounds weight, shot out of a cannon. Thus we find that it was necessary that light should fly with prodigious swiftness, otherwise its influence would have been of little or no benefit to us : it was necessary that its particles should be most exceedingly small, otherwise it would have broke almost every thing in pieces : it was necessary that its rays in its passage should continually separate and divide from each other, otherwise it would have set the whole earth on fire. Light has likewise two other properties, that are of the greatest service to us ; which are, that its rays are capable of being refracted or turned out of their course in passing from one medium into another, as from air into water, or glass ; and great part of it is likewise reflected back from almost all bodies. Let us, then, look upon it as a cause whose Author is all wise, all powerful, who dwells in light inaccessible in the heavens.

Sound.

The vast swiftness with which sound flies, is likewise worth observing and admiring, being fifty-two times greater than that of a brisk wind, or current of air : it is by this property rendered of a much

greater use to us, than if its motion had been slower. Sound, by repeated experiments that have been made, is known to fly no less than one thousand one hundred and forty two feet in one second of time; or the sixtieth part of a minute; and whether the sound be loud or languid, whether of bells, guns, &c. great or small, or any other sonorous body, it flies with the same incredible swiftness; nor does it lessen the farther it goes, but passes over the last mile as quick as it did the first; neither does the difference of day or night, summer or winter, heat, or cold make any difference in the swiftness of its progress: in all these changes it keeps on its course, without being quickned or retarded by any of them; even flying against the wind it moves with nearly the same swiftness, but more or less loud as the wind is with or against it. Upon many occasions we have need to call people to our immediate assistance who are at a distance; was then the motion of sound slow, we should perish before they would know that we wanted help: thus in the accidents of fire the whole country around, by the ringing of a bell, is informed of it in much less than a minute, and immediately hasten to the assistance of the distressed; but if sound, instead of flying a mile in four seconds of time, was to be four hours in going that distance, a town might be burnt down, before sufficient help could be called for. Thus in the time of war, how necessary is the quick motion of sound to inform a whole city of the approach of an enemy, and which gate or part they attack, that they may all hasten to the defence of that spot. What loss of time would have arose had the motion of sound been slow, in calling any part of a family, what time would be lost in waiting for an answer, and the difficulty would have been as great in many cases.

Sound is conveyed in circles of the air, just like those we see made in the water upon striking or sinking any thing into it; one circle saith another, all

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the agitation of the water is subdued; now, though they both act in the same manner, over the circles of the air are formed eight hundred and sixty-five times quicker than those of the water.

The distances sound will reach to, is no less wonderful than its swiftness: a Gentleman of great veracity, who lived some years at *Gibraltar*, affirms that he has at *Old Gibraltar*, heard the watch-word of the night (viz. "all's well") given by the centinel to the patrol on the ramparts of *New Gibraltar*, in a still serene night, and that as plain and distinct he thought, as he should have done had he been on the rampart himself: the bay between the two places he judged to be about ten English miles and a half. Many other instances are there to prove at what a vast distance sound may be heard, but what has been explained, it is hoped, will give satisfaction to every impartial reader.

CHAPTER XI.

LET us next consider the element of water; which we shall find no less fitly and wonderfully disposed for our service; what immense advantages arise to us from water carriage? how easily by this means we may transport vast weights and quantities of goods from one part to another, even to the greatest distance, which we could by no means do without the help of water; that by its means a speedy and easy communication is made of all parts of the world with one another; that it not only sup-

ports a prodigious weight, but keeps it suspended in so exact an equilibrium, that a very small force is sufficient to determine its motion one way or other as we please; so that two or three men, with oars, horses, or wind, may convey forty or fifty tons by water from place to place, which by land would require near two hundred horses, forty carts and as many men. By water's being of the consistency it is we can make use of mills for various purposes, which are put in motion by this element; but had it been of a lighter nature, and its force not increased by motion, our water mills would have been useless; and had it been of a thicker consistence than it is, it would have been no less unfit for our use; for then it would have stood still or stagnated, instead of running, as it now does, every where to communicate its blessings to all parts: it would not have penetrated into the roots and fibres of trees and plants, to give them their nourishment; neither would it have been of that infinite service, as it now is to all creatures, in satisfying their thirst, and diluting the food they eat, so as to make it the fitter for nourishment. There are two other properties of water; which, though not so obvious, are the means of making it of greater use to us, viz. its easiness to be turned any way, or brought into any compass or shape that we please: by this means, if we have occasion to water our meadows, we need only cut a few trenches from the river, and we can by that means conduct it to every part: if we have occasion to bring it into our houses, it without difficulty enters into any pipes we lay for its conveyance; if we want to bring it into a smaller compass, it obeys our desires, it waits but the pleasure of man to change its former course, and to enter into what ever channel he thinks fit to prepare for it.

Another property of water is, that it will always rise again to the same height that it falls from: had this property only, been wanting in water, how

much would it have lessened the blessings? all our rivers, brooks, and pleasant running streams, must have stopped at the first rising they came to, and all the benefit of rivers and other streams would have been entirely lost to the greatest part of the earth; but the wise Creator endued water with this property of rising as high as it falls from, and then placed the sources, or springs of rivers and brooks, in hills and mountains; by which means they acquire a sufficient force to run through whole countries, notwithstanding the inequality of the earth's surface, and the risings which they meet with in their course. Had the waters been left to stagnate in pits, they would have bred such damps, as would have rendered it too unwholesome for us to live any where near them; and had they not been distributed in almost every place, it would have been no less injurious to us, for excessive draught is as fatal as damps and fogs; whereas it is certain that every little rivulet refreshes and purifies the air of all the adjacent places with its gentle exhalations, and cleanses the earth of all filth and nastiness: the fruitfulness of lands is likewise generally owing to the neighbourhood of rivers; how vast the difference betwixt a country that is watered by a river, and one that is destitute of that convenience! the latter is barren and dreary, whilst the other is almost a paradise; for it is not only the trees and meadows which lie just upon the banks of it, that a river makes this great alteration, but upon the whole country round for several leagues; for it is certain that the fruits of the earth receive their nourishment as well from their leaves as roots, inasmuch, that oftentimes when the earth is almost exhausted of its humidity, having scarce any left wherewith to feed the roots, the dew alone which falls upon the leaves in the night-time, being sucked in and distributed through the whole plant, does supply it with moisture. It is the brooks and

rivers that are the principal magazines that supply this necessary expence of moisture, which exhaling from them in mists, are carried by the wind to fall down again in refreshing dews, not only upon those places which border upon the rivers, but also on such as are several leagues distant from them. Thus do all parts of nature mutually help and assist each other, declaring themselves, in the wonderful variety of their operations, to be all the handy-work of the same Author and Artificer; as they do undeniably demonstrate his kind and providential regard to our happiness and welfare. And as this element is of such infinite service to us for various uses, what an instance of goodness and design is it, that it is dispersed throughout the whole earth! what a vast length are many rivers, viz. the *Rhine* is above six hundred miles, the *Danube* fifteen hundred, and the *Niger* waters three thousand three hundred miles of land in the vast, burning, sandy deserts of *Africa*, the river of *Amazons* in *America*, runs three thousand miles, and discharges itself into the ocean by an outlet, two hundred and fifty-two miles in breadth; besides there are many others of equal length, and some which are supposed to run the vast course of six thousand miles; when we consider this, our reason tells us that nothing but the omnipotent hand of God could form and hollow such channels from one end of the earth to the other. The whole distribution of the waters, and the dry land, although it may seem rude and undesigned to a careless view, yet is admirably well adjusted to the uses and conveniences of our world: for in the first place, the distribution is so well made, the earth and waters so handsomely, so workman-like laid, every where all the world over, that there is a just equipoise of the whole globe: the Northern balanceeth the Southern ocean, the Atlantic the Pacific sea: the American dry land is a counterpoise to the European, Asiatic, and African dry land.

In the next place the earth and waters are so admirably well placed about in the globe, as to be helpful to one another's uses: the great oceans, and the lesser seas and lakes, are so admirably well distributed throughout the globe, as to afford sufficient vapours for clouds and rain, to temperate the cold of the northern frozen air, to cool and mitigate the heats of the torrid zone, and to refresh the air with fertile showers; nay so abundant is the great blessing which the indulgent Creator hath offered us, by the means of this distribution of the waters, that there is more than a scanty bare provision, or mere sufficiency; even a plenty, a surplussage of this useful creature of God (the fresh waters) afforded to the world, and they are so well ordered, as not to drown the nations of the earth, nor to stagnate, sink and poison, or annoy them; but to be gently carried through convenient channels to that vast immense receptacle of waters the sea, which is in itself so astonishing a wonder, that it confounds the imagination. Who has prepared for the water so capacious a bed? who but the almighty God?

Clouds, Rain, Hail and Snow.

First of Clouds and Rain.

The clouds and rain are of the utmost service to us, as is manifest in the refreshing pleasant shades which the clouds afford, and the fertile dews and showers which they pour down on the trees and plants, which would languish and die with perpetual drought, but are hereby made verdant and flourishing, gay and ornamental: clouds and rain are made

of vapours raised from water or moisture only; these vapours are demonstratively no other than small bubbles or bladders detached from the waters by the powers of the sun, or the subterraneous heat, or both; and being lighter than the atmosphere, are buoyed up thereby, until they become of an equal weight therewith, in some of its regions aloft in the air, or nearer the earth; in which these vapours are formed into clouds, rain, hail, snow, lightning, dew, mists, and other meteors. In this formation of meteors, the grand agent is cold; which commonly, if not always, occupies the superior regions of the air, as is manifest from those mountains which exalt their lofty tops into the upper and middle regions, and are always covered with snow or ice: this cold, if it approaches near the earth, presently precipitates the vapours, either into dews, or if the vapours more copiously ascend, and soon meet the cold, they are then condensed into misting, or else into showers of small rain, falling in numerous, thick, small drops: but if those vapours are not only copious, but also as heavy as our lower air itself (by which means their bladders are thick and fuller of water) in this case they become visible, swim but a little height above the earth, and make what we call a mist or fog. But if they are a degree lighter, so as to mount higher, but not any great height, as also meet not with cold enough to condense them, nor wind enough to dissipate them, they then form an heavy, thick, dark sky, lasting oftentimes for several weeks, without either sun or rain, and in this case, it is scarce ever known to rain, till it hath been first fair, and then foul.

And from what hath been said, the case is easily accounted for, viz. whilst the vapours remain in the same state, the weather doth so too; and such weather is generally attended with moderate warmth, and with little or no wind to disturb the vapours, and an heavy atmosphere to support them, the barometer

being commonly high then: but when the cold approacheth, and by condensing drives the vapours into clouds or drops, then is way made for the sun beams, till the same vapours, being by further condensation formed into rain, and fall down in drops. The cold's approaching the vapours, and consequently the alteration of such dark weather, is often before-hand perceived, by some few small drops of rain, hail, or snow, now and then falling, before any alteration hath been in the weather; which probably is from the cold meeting some of the straggling vapours, or the uppermost of them, and condensing them into drops, before it arrives unto, and exerts itself upon the main body of vapours below.

From what has been said it appears, that the clouds are a vast heap of vapours exhaled from sea and land, and raised to that height in the air, where they become of equal weight or gravity with the air; in those parts therefore they float and swim, and by striking one against the other, and mixing one with another, they coalesce, or thicken, and become more dense and weighty. The thinner or rarer the clouds are the lighter and higher they soar; but the more dense they are, the weightier: and the nearer they ride to the earth. The clouds are from about a quarter of a mile to a mile high. The wonderful variety in the colours of clouds, is owing to their particular situation to the sun, and the different reflections of his light: the various figure of the clouds results from their loose and voluble texture, revolving into any form, according to the different force of the winds. When various heaps of clouds are driven together by the agitation of the winds, they mix and run into one body, and thus dissolve and condense each other into their former substance of water; also the coldness of the air is the greatest means to collect, compact, and condense clouds into water.

The manner how vapours are precipitated by the cold, or reduced into drops, is conceived to be thus: vapours being as we have said, no other than inflated bladders of water; when they meet with a colder air than what is contained in them, the contained air is reduced into a less space, and the watery shell or case rendered thicker, by that means so as to become heavier than the air, by which they are buoyed up, and consequently must needs fall down: also many of those thickned bladders run into one, and so form drops, greater or smaller, according to the quantity of vapours collected together. As to the rain of different places, we have in some of our *Philosophical Transactions*, the quantity assigned, particularly in No. 321 we have these, viz. The depth of the rain in one year with another, in English measure, if it was to stagnate on the earth, would amount unto at *Townly* in *Lanenshire*, forty-two inches and a half; at *Upminster* in *Essex*, nineteen inches and a quarter; at *Zurich* in *Switzerland*, thirty-two inches and a quarter; at *Pisa* in *Italy*, forty-three inches and a quarter; at *Paris* in *France*, nineteen inches; and at *Lisle* in *Flanders*, twenty-four inches.

Hail.

Hail is thus generated: when the cloud which raineth is very high in the air, or when all the regions of the air are very cold, the falling drops of water are congealed thereby, and grow into a glacy substance, somewhat white and hard, of different size and figure, according to the particles of water, the degrees of heat and cold, and the wind, &c.

Snow.

Snow is produced thus: when the vapours are become considerably condensed, yet not so far as to

become liquified, or dissolved into water, then by a special degree of coldness in the upper air, the particles of the condensed vapours are compelled into a hard, rigid, and glacy substance, several of which adhering together, form little fleeces of a white substance, somewhat heavier than the air; and therefore descend in a slow gentle manner,

The Causes of Ice, Thunder, Lightning, the Aurora Borealis, Ignis Fatuus, and the Rainbow.

First, Ice and freezing are supposed to be the effects of nitrous particles which being sharp and pointed, insinuate themselves into the pores of water, dew, &c. and thereby fix, crystalize, and harden the superficies thereof into those substances which we call ice, &c.

Secondly, Thunder proceeds from an heterogeneous commixture of the effluvia or exhalations of sulphurous, nitrous, and inflammable bodies in the air, which ferment, kindle into flames, and make horrible exploisions (like gunpowder) which we call thunder and lightning.

Thirdly, The Aurora Borealis, or northern lights, are produced also from nitro-sulphurous vapours, which are thinly spread through the atmosphere higher than the clouds, and by fermentation take fire, and the exploision of one portion kindling the next, the flashes succeed one another till all the vapours within their reach are set on fire; the streams whereof will appear to converge towards the zenith of the spectator, or the point over our heads.

Fourth, The Ignis Fatuus or Jack-with-a-lan-thorn, is supposed to be nothing else but a fat unctuous and sulphurous vapour, which appears fluid, and is wafted about by the air, near the earth's surface,

Like a light in a lanthorn : such like vapours kindling in the serene air in the night, appear like falling stars, and are therefore so called.

Lastly, The Rainbow, one of the finest phenomena of nature, exists in falling rain or dew, and is produced by reflection and refraction of the sun's rays in the aqueous particles : the manner whereof, and the wonderful properties of the bow, too large and many to be here explained, may be seen in Mr. MARTIN's *Philosophical Grammar*.

And now let us pause a little and reflect :---and, upon the whole matter, what less can be concluded, than that there is a Being infinitely wise, potent and kind, who is able to contrive and make this glorious scene of things?

CHAP. XII.

NATIONS compared with each other, &c.

THE first difference, in comparing a barbarous with a polite nation, that visibly offers, is the longevity of the inhabitants of polished countries, above the savage tenants of the forest. A life of seventy, eighty, and even an hundred years, is very common in several parts of Europe, where the inhabitants are reduced into fixed society : but through all the wilds of *Tartary*, nay, if we extend the view to the nothern parts of *America*, that life is thought long which reaches threescore.

The vicissitudes of season, the long fastings, the consequent repletion upon finding the precarious meal, swimming rivers, while warm with the chase,

and long protracted vigils, all contribute to shorten the human span, and no habitude can reconcile them to our natures. From hence we see how very wrong those parents are, who attempt to improve the health and strength of their children by too hard an education; and though some may survive such attempts, they seem insensible how many die under the experiment. Peter the Great, in order to teach some children to be perfect sailors, instituted, that they should be permitted to drink only sea-water; their instructors obeyed the order, but all the children died.

There are still however some physical causes which contribute to keep the inhabitants of those extensive regions barbarous; and among the rest may be reckoned the want of corn. In those countries, which lie even in a more southern latitude than England, the inhabitants find that they are incapable of producing corn. To what shall we attribute this surprising defect? Not to the soil, for that is at once deep and fertile, nor to the coldness of the climate, for colder climates in Europe produce corn in abundance: to their immense forests alone can this defect of vegetation be ascribed. Every tree has its own humid atmosphere around it, inasmuch that farmers generally find their neighbourhood noxious to fields of corn; a forest of trees, by loading the atmosphere with too much humidity, is still more hurtful. If we examine the soil upon which forests stand, we shall in general find it cold, moist, and covered with water; in such therefore it cannot be expected corn should be produced in any quantities; and even tho' the forests should be cleared away, yet this cannot be done to such a sufficient extent as to prevent the humidity of the wide-extended neighbouring forest, to injure every labour of the husbandman.

Thus we see every country capable only of a gradual improvement, as well with regard to its natural qualities, as to the moral character of its inhabitants. The soil must be cleared, not in spots, but in tracts,

the most extensive, before it acquires any degree of fertility; the inhabitants must become numerous before they grow polite.

Attempting to introduce polite manners into a barbarous and ill-peopled country, is as vain an endeavour, as by clearing away in the midst of a forest, to attempt to produce corn. Politeness may be introduced into any country too soon; and in that under our notice this actually has been the case.

Their great monarch Peter erroneously fancied, that by sending the inhabitants of a polished country, to people those regions, he would improve the original inhabitants in the duties of society; time however has shewn, that those unhappy gentlemen who were banished to this region of desolate sterility, were incapable of introducing happiness among the natives; with all their arts and knowledge, were even more helpless than the meanest of them: Nature, that true benefactor of mankind, quickly evinced, that savage customs were the most fit for savage inhabitants. The polite Europeans, with all those refined desires of education, and liable to all those wants which arise from connected society, found themselves among a people, whose only wish was to live, who placed more happiness in the greatness than delicacy of the meal, who were unaccustomed to these fictitious wants, which arise when our real necessities are supplied; who were insensible how those, who wanted no sensual enjoyment, could still be unhappy: what then could missionaries do in such a country? They were, instead of refining the inhabitants, obliged to comply with their barbarous manners; and instead of bringing over the country from barbarism, they became themselves barbarians.

Peter should have behaved as the Portuguese did, in similar circumstances, to the polite Chinese, already instructed in the luxuries of life. They sent mil-

sionaries, who were capable of improving them in speculative knowledge, and the sciences, and such messengers were gladly received. to the wild Americans, they, on the contrary, sent men who had less learning and more perseverance; men who were capable of instructing the inhabitants how to cultivate the earth, and to improve the productions of nature.

Let us then here pause, to consider the wisdom of man in suiting himself to the climate, the soil, the society in which he has been born. Those peculiarities, which we are too apt to call barbarous, because they differ from our own, are often the effect of fine contrivance and well-guided sagacity. Should we, for instance, condemn the clumsy shoe of an inhabitant of the north, how justly might he laugh at our ignorance, since they prevent him from sinking in the deep snows, with which the country is generally covered? Should we call the Tartar barbarous, because he eats his horse, would he not justly deride our delicacy, since the flesh of animals, as they approach the north, is in general more tender than that of southern animals; and horse-flesh in Tartary is probably the greatest delicacy they have? Should we object to his fondness for distilled milk, who knows but this may be a delicacy yet untasted in Europe, as the preparation is certainly a chymical secret unknown to the politest European, who are incapable of extracting a spirit from milk? Should we condemn them for keeping the bodies of the dead longer than we, they may justly answer, that with them bodies are found not to corrupt so soon as with us; and as no inconvenience attends this custom, it is but an innocent mark of respect to the dead. If their language be defective and barren, they have but few ideas, and consequently do not want a language more copious. They want an exalted understanding; and happy it is for them that they labour under this defect. The greatest understanding of an individual, doomed to

procure food and cloathing for himself, can but barely supply him expedients to prolong his existence from day to day. But should we suppose him one of a large community, performing only his share of the common business, he then gains leisure for intellectual pleasures, and enjoys the happiness of reason and reflection.

Proceeding in our intellectual map, we now descend lower, to those happy climates possessed by the polite inhabitants of the temperate zone, where the soil hath been fertilized by long culture, where the river glides in a channel not its own, where all nature seems to put on the face of art, where the brute animals are in perfect subjection, and calmly receive laws from man; to regions, along which the surveyor has laid his measuring-line where every lawn and fountain is claimed by some proprietor.

Happy were it for those climes, did not the same inconveniencies arise from too great a population, which in the countries already described proceed from being too thinly inhabited. The more a country is peopled to a certain degree, the better; but there is a point beyond which even a multiplicity of inhabitants render each other unhappy. It is then that penal laws are encreased, that wars are engaged in, in which the end only serve to lessen the number. Among polite nations whatever may be the pretext for war, if it be examined to the bottom, will be found to proceed from a nation, by long peace becoming too numerous, and consequently desirous of occupying those regions possessed by another: instigated by the same motives, the rival nation answers the challenge, both fight; some two or three hundred thousands are slain on either side; and each nation thus diminished of its inhabitants, now begins to look round, and to find that the survivors are not too numerous to destroy each other's internal welfare. Thus a peace is concluded, which leaves both nations in the very same circumstances in which they began the war; with

only this difference, that the inhabitants on both sides are reduced, and more nearly proportioned to the extent of the country which they possess.

If we compare the encrease of a colony newly planted, with that of an equal number of the mother-country at home we shall in general find, that the former breed up five children for one bred up by the latter. In the mother-country, from being already too populous, marriages are not entered into, as the contracting parties are not able to maintain their offspring: in colonies, where a proper extent of country is presupposed, nothing more than increase of labour is sufficient to maintain a numerous progeny, which growing up, are soon able without further assistance to maintain them selves. Thus colonies have ever cultivated commerce rather than war, untill they could spread no farther; and then, from the natural inconvenience of too great population they arrived at attempting to invade that property among their neighbours by force which they were unable to possess by legal means. War, therefore, unceasing war is the consequence of refined society: it is a natural evil, which arises from the nature of an happy and well regulated constitution, which must increase; and every country is capable of supporting only a determinate number of inhabitants.

If we compare the bodies of the inhabitants of the temperate climates with those which lie to the north or south, we shall find the pores of the skin much larger than in any other part of the globe, and a manifest difference in this particular. Excessive heat or cold contract the pores of the skin; and those who have been long accustomed to either, are found no way subject to those profuse sweats, which in every part of Europe are the consequences of labour: from hence the Europeans derive a continuance of youth and vigour; for their bodies daily losing on one part, and receiving new supplies on another, are continually changing; and, if we may so express it,

are thus always new : whereas in the cold and hot climates, the bodies of the natives do not receive so easily addition and loss, and consequently continue more constantly the same. This will sufficiently account for the difference between climates, in respect to youth and age ; an inhabitant of the north, or the equator, is old at twenty-five, but continues to support nature in this state of premature debility for several years ; while an European, on the contrary, seldom feels either the effects, or discovers the wrinkles of age, till he is past fifty, and then declines into the vale of years with precipitation.

That permanent vigour of the body is also the most proper to supply a fund of materials to supply the mind ; as the soul often sympathizes with the decaying outward frame, before an inhabitant of the frigid or torrid zone has an opportunity of growing learned, he is grown old : the season for memory and invention is past ; and he is, from the natural infirmities consequent upon age, more desirous of preferring the acquisitions of knowledge he has made, than of treasuring up new. On the contrary, the philosopher of the temperate climate, has a long period in which to collect his inductions ; and as from the nature of the climate, a greater variety of objects offer instruction, so he has a longer period to enjoy the fruits of his acquisition.

On Men, Manners, and Things.

A Brave man is not suddenly elated by prosperity, or depressed by adversity ; so the oak displays not its verdure on the sun's first approach ; nor droops on its first departure.

The works of a person that builds, begin immediately to decay ; while those of him who plants be-

gin directly to improve : in this, planting promises more lasting pleasure than building.

We have observed universally, that the quarrells of friends in the latter part of life are never truly reconciled : a wound in the bark of young trees may be soon grown over, as to leave no scar ; the case is different in regard to old people and timber : the reason of this may be accountable, from the decline of the social passions, and the prevalence of spleen, suspicion and rancour, towards the latter part of life.

There is nothing so disagreeable, as to hear weak and servile people repeat with admiration every silly speech that falls from a person of rank and fortune : the nonsense grows more nauseous thro' the medium of their admiration, and shews the venality of vulgar tempers, who consider fortune as the goddess of wit.

What pleasure it is to pay one's debts ! it seems to flow from a combination of circumstances, each of which is productive of pleasure : in the first place, it removes that uneasiness which a true spirit feels from dependance and obligation : it affords pleasure to the creditor, and thereby gratifies social affection : It promotes that future confidence which is so very interesting to an honest mind : it opens a prospect of being readily supplied with what we want on future occasions : it leaves a consciousness of our own virtue ; and it is a measure we know to be right, both in point of justice and sound economy : finally, it is a main support to simple reputation.

I cannot see why a person should be esteemed haughty on account of his taste for fine cloaths, any more than one who discovers a fondness for birds, flowers, &c. imagination influences both to seek a mulement in glowing colours. It appears to me, a person may love splendour, without any degree of pride, which is never connected with this taste : but, when a person demands homage on account of the

finery he exhibits, then it ceases to be taste, and commences mere ambition: yet the world is not enough candid to make this essential distinction.

The first instance an officer gives you of his courage, consist in wearing cloaths superior to his rank.

There are certain shapes and physiognomies of so vulgar a cast, that they would scarce win respect tho' they were embellished with a dress as tawdry as a pulpit cloth.

Perhaps an acquaintance with men of genius is rather reputable then satisfactory: it is as accountable as it is certain, that fancy heightens sensibility, strengthens passion; and passion makes people humorists. Yet a person of genius is often expected to shew more discretion than another man; and this on account of that very vivacity which is his greatest impediment: this happens for want of distinguishing betwixt the fanciful talents, and the dry mathematical operations of the judgment; each of which, indiscriminately, gives the denomination of a man of genius.

The best time to answer the letters of your friends is the moment you receive them; then the warmth of friendship, and the intelligence received, must forcibly co-operate.

Prudent men should lock up their motives; giving only their intimates a key.

C H A P. XIII.

The Art of D R A W I N G.

THOUGH some may look upon Drawing as one of those accomplishments which are rather ornamental than useful, yet so elegant and agreeable amusement for the leisure hours, as the art of drawing affords, should by no means be neglected in the education of youth; especially where any genius or inclination that way is discovered in the pupil: and we are so far from being of opinion that it is merely ornamental: for besides, it is of great use to Painters, Engravers, Architects, Engineers, Gardeners, Cabinet-makers, Carvers, Embroiderers, Statuaries, Tapestry-weavers, and many others concerned in Designing.

Of the proper Materials, and the Manner of using them.

The first thing necessary is to furnish yourself with proper materials, such as black-lead pencils, crayons of black, white, or red chalk; crow-quill pens, a rule and compasses, camel's-hair pencils, and indian ink. Accustom yourself to hold your pencil farther from the point than you do a pen in writing, which will give you a better command of it, and contribute to render your strokes more free and bold. The

use of your pencil is to draw the first sketch or outlines of your piece, as any stroke or line that is a-miss, may in this be more easily rubbed out than in any other thing; and when you have made your sketch as correct as you can with the pencil, you may then draw carefully the best out-line you have got with your crow-quill pen and Indian ink; after which you may discharge the pencil-lines, by rubbing the piece gently with the crumbs of stale bread. Having thus got your out-line clear, your next work is to shade your piece properly (for which we shall give more particular directions in another lesson) either by drawing fine strokes with your pen where it requires to be shaded, or by washing it, with your hair pencil, and the indian ink. As to your rule and compasses, they are never or very rarely to be used, except in measuring the proportions of your figures after you have drawn them, to prove whether they are right or not; or in houses, fortifications, and other pieces of architecture.

Of drawing Lines, Squares, Circles, and other regular and irregular Figures.

Your first practice must be to draw straight and curv'd lines, with ease and freedom upwards, downwards, sideways to the right or left, or in any direction whatsoever: you must also learn to draw by command of hand, squares, circles, ovals, and other geometrical figures; for as the alphabet, or a knowledge of the letters, is an introduction to grammar, so is geometry to drawing. Be sure to make yourself perfectly master of one figure before you proceed to another; the advantage, and even necessity of this, will appear as you proceed. It is practice more than precepts that must teach you the art of drawing.

Two observations more may be proper with regard to drawing: one is, that the pupil accustom himself to draw all his figures very large, which is the only way of acquiring a free, bold manner of designing; the other is, that he practice drawing till he has gained a tolerable mastery of his pencil, before he attempts to shadow any figure or object of any kind whatever.

Light and Shade.

It is this which gives the appearance of substance, shape, distance and distinction, to whatever bodies you endeavour to represent, whether animate or inanimate: your best rule for doing this, is to consider from what point, and in what direction the light falls upon the objects which you are delineating, and let all your lights and shades be placed according to that direction throughout the whole work: that part of the object must be lightest which hath the light most directly opposite to it; if the light falls sideways on your picture, you must make that side which is opposite to it lightest, and that side which is farthest from it darkest. If you are drawing the figure of a man, and the light be placed above the head, then the top of the head must be made lightest, the shoulders next lightest, and the lower part darker by degrees. That part of the object whether in naked figures, or drapery, or buildings, that stands farthest out, must be made the lightest, because it comes nearest to the light; and the light loseth as much of its brightness, by how much any part of the body bends inward, because those parts that stick out hinder the lustre and full brightness of the light from sticking on those parts that fall in. TITIAN used to say, that he knew no better rule for the distribution of lights

and shadows, than his observations drawn from a bunch of grapes. Satins and silks, and all other shining stuffs, have certain glancing reflections, exceeding bright where the light falls strongest: the like is seen in armour, brass pots, or any other glittering metal, where you see a sudden brightness in the middle, or centre of the light which discovers the shining nature of such things. Observe also, that a strong light requires a strong shade, a fainter light a fainter shade; and that an equal balance be preserved throughout the piece between the lights and shades. Those parts which must appear round require but one stroke in shading, and that sometimes but very faint; such parts as should appear deep or hollow, require two strokes across each other, or sometimes three, which is sufficient for the deepest shade. Take care also to make your out-lines faint and small in such parts as receive the light; but where the shades fall, your out-line must be strong and bold. Begin your shadings from the top, and proceed downwards, and use your utmost endeavours both by practice and observation to learn how to vary the shadings properly, for in this consists a great deal of the beauty and elegance of drawing. Another thing to be observed, that as the human sight is weaken'd by distances, so objects must seem more or less confus'd or clear according to the places they hold in the piece: those that are very distant, weak, faint, and confus'd: those that are near and on the foremost ground, clear, strong, and accurately finished.

Drawing Flowers, Fruits, Birds, Beasts, &c.

The best thing you can do is to furnish yourself with good prints or drawings by way of examples, and with great care and exactness to copy them: if

it is the figure of a beast, begin with the forehead, and draw the nose, the upper and under jaw, and stop at the throat; then go to the top of the head, and form the ears, neck, and continue the line till you have given the full shape of the buttock; then form the breast, and mark out the legs and feet, and all the smaller parts, and last of all finish it with the proper shadows. It is not amiss, by way of ornament, to give a small sketch or landscape, and let it be suitable and natural to the place or country of the beast you draw: much the same may be said with regard to birds.

Drawing Eyes, Ears, Legs, Arms, Hands, Feet, &c.

As to the drawing of eyes and ears, legs and arms, you will have very little more to do than to copy carefully the examples which are given you in plates; but the actions and postures of the hands are so many and various, that no certain rules can be given for drawing them, that will universally hold good: yet as the hands and feet are difficult members to draw, it is very necessary, and well worth while, to bestow some time and pains about them, carefully imitating their various postures and actions, so as not only to avoid all lameness and imperfection, but also to give them life and spirit. To arrive at this, great care, study, and practice are requisite; particularly in imitating the best prints and drawings you can get of hands and feet, for as to the mechanical rules of drawing them by lines and measures, they are not only perplexed and difficult, but also contrary to the practice of the best masters. One general rule however may be given (which is universally to be observed in all subjects) and that is,

not to finish at first any single part, but to sketch out faintly and with light strokes of the pencil, the shape and proportion of the whole hand, with the action and turn of it; and after considering carefully whether this first sketch be perfect, and altering it wherever it is amiss, you may proceed to the bending of the joints, the knuckles, the veins, and other small particulars, which, when you have got the whole shape and proportion of the hand or foot, will not only be more easily, but also more perfectly designed.

Drawing Faces.

The head is usually divided into four equal parts; 1. from the crown of the head to the top of the forehead; 2. from the top of the forehead to the eyebrows; 3. from the eyebrows to the bottom of the nose; 4. from thence to the bottom of the chin; but this proportion is not constant; those features in different men being often very different as to length and shape: in a well proportioned face, however, they are nearly right. To direct you therefore in forming a perfect face, your first business is to draw a compleat oval, in the middle of which, from the top to the bottom draw a perpendicular line, through the centre or middle of this line draw a line diametrically across from one side to the other of your oval: on these two lines all the features of your face are to be placed as follows: divide your perpendicular line into four parts; the first must be allotted to the hair of the head, the second is from the top of the forehead to the top of the nose between the eyebrows; the third is from thence to the bottom of the nose, and the fourth includes the lips and chin. Your diameter line, or the breadth of the face, is always supposed to be the length of five eyes.

you must therefore divide it into five equal parts, and place the eyes upon it so as to leave exactly the length of one eye betwixt them: this is to be understood only of a full front face; for if it turns to either side, then the distances are to be lessened on that side which turns from you, less or more in proportion to its turning: the top of the ear is to rise parallel to the eyebrows, at the end of the diameter line; and the bottom of it must be equal to the bottom of the nose: the nostrils ought not to come out farther than the corner of the eye in any face, and the middle of the mouth must always be placed upon the perpendicular line. There is an ingenious device which perhaps may assist you in forming the face according to its different turnings, and in placing the features properly thereon. Procure a piece of box or other smooth even coloured wood, and get it turned in the shape of an egg, which is pretty nearly the shape of the human head; draw a line upon it from point to point longways: divide this line into two equal parts, and draw another thro' that point directly across it at right angles, the features being drawn on these two lines according to the rules given you above, which will produce a fore right face. Turn the oval a small matter from the left hand to the right, and the perpendicular will appear bent like a bow or arch, upon which the particular features are to be drawn, always observing in what manner the nose projects beyond the round of the oval: the same must be observed if you turn the oval from the right to the left. A great variety of faces may be shewn on this oval, according as you incline, recline, or turn it more or less; and a side face may be drawn by means of a perpendicular, on which the forehead, nose, mouth, and chin are to be described. These rules being thoroughly understood, and imprinted in your mind by frequent practice, we doubt not but you will be able in a little

time to draw faces from your own fancy and invention; and you will be better grounded in the art than those who merely draw from prints or pictures, without understanding any thing of the rules: but after this, we would have you carefully study and copy after the best drawings or pictures you can procure.

Designing.

Designing is the art of delineating or drawing the appearance of natural objects by lines on a plane. It is particularly used with painters for the idea of a large work, drawn roughly, with an intention to be executed and finished with propriety. In the simplest sense, the design is the contour or out-line of the figures or things intended to be represented, or the lines that terminate and circumscribe them. Such a design is sometimes drawn in crayons or ink, without any shadows at all: sometimes it is hatched, that is, the shadows are expressed by sensible lines, usually drawn across each other, with the pen, crayon, or engraver: sometimes again the shadows are done with the crayon rubbed, so that no lines do appear at all; and sometimes the grains or strokes of the crayon appear as not being rubbed. Sometimes the design is washed, that is the shadows are done with a pencil in indian ink, or in some other liquor; and others the design is coloured, that is, colours are laid on, much like those intended for the grand work.

The qualities or parts, required in a design, are correctness, good taste, elegance, character, diversity, expression, perspective. Taste, is an idea or manner of designing, which arises either from the complexion or natural disposition, or from education, the masters, studies, &c. Correctness, depends prin-

cipally upon the justness of the proportions, and a knowledge of anatomy. Elegance, gives the figure a kind of delicacy, which strikes people of judgment, and a certain agreeableness, which pleases every body. The character, is what is peculiar to each thing, in which there must be a diversity, inasmuch as every thing has its particular character to distinguish it. The expression, is the representation of an object, according to its character, and the several circumstances it is supposed to be in. The perspective, is the representation of the parts of a painting or figure, according to the situation they are in, with respect to the point of sight.

The design or draught is a part of the greatest import and extent in painting; it is acquired chiefly by application, the principal rules are as follows:

1. That young beginners accustom themselves to copy after good originals at first sight; not to use squares in drawing, for fear of stinting and confining their judgment.

2. To stay till they can design well after the life, before they begin the practice of perspective rules.

3. In designing after the life, to learn to adjust the bigness of their figures to the visual angle, and the distance of the eye from the model or object.

4. To mark out all parts of their design, before they begin to shadow.

5. To make their contours in great pieces, without taking notice of the little muscles and breaks.

6. To make themselves masters of the rules of perspective.

7. To observe every stroke as to its perpendicular, parallel, and distance; and particularly so, to compare and oppose the parts, which meet upon and traverse the perpendicular, so as to form a kind of square in the mind; which is the great, and almost the only rule of designing justly.

8. To have a regard not only to the model, but also to the part already designed; there not being any such thing as designing with strict justice, but by comparing and proportioning every part to the first; the rest have a relation to perspective.

C H A P. XIII.

P A I N T I N G.

Oils necessary.

THE best Oils that can be used in Painting are oil of *Nuts* and *Linseed* oil. Oil of *Spike*, which is made of *Lavender* flowers, serves to make the colours run better, and renders the touching the picture over again the more easy; it also takes off the glittering of a picture, and is proper to do the same by the filth and clean it: but the painter must take care it does not take off the colour too.

Oil of *Turpentine*, which is drawn from *Resin*, is good to touch a picture over again with; but especially to mix with *Ultramarine* and *Enamels*; because it helps to spread them, and evaporates immediately. When the artist would make use of it, it is not necessary he should make use much of other oil, which will only turn the colour yellow.

Oil of *Nuts*, is used by painters, boiled up with the seum of *Lead*, in which *Silver* has been melted by a quick and great fire; to this add an *Onion* whole and peeled, which is taken out after it has boiled: this takes away from the oil its greasy quality. Oil of *Nuts* is also boiled with powder of *Azure* and *Enamel*, which being boiled, is set to stand a little, and

then the top taken off. This is used to temper *White*, and the other colours, which the painters would have be kept clean.

Oil of Turpentine is used to dissolve the colours, and make them spread the better, and to make the work dry the sooner.

Fat Oil: put *Linseed* oil into leaden vessels, made in the form of dripping-pans, so much as to be an inch deep; expose them to the sun for six months, till it becomes as thick as *Turpentine*; the longer it stands the fatter it will be, and give Gold a greater gloss. If it is almost as thick as butter, so as you may in a manner, cut it with a knife, it is excellent, and ought to be carefully kept for use.

To make Drying Oil: mix a quart of *Linseed* oil with three ounces of *Litharge* of Gold, and boil them for a quarter of an hour; but if you would have it more drying, boil it a little longer; but beware of boiling it too thick, so as not to be fit for use.

Colours.

The chief *Whites* are *Spodium*, *Cerafs*, *White Lead*, *Spanish White*, and *Egg shells burnt*. The *Spanish White* is thus made: take fine *Chalk* six ounces, *Allum* two ounces; grind them together in fair water, till it be like pap; roll it up into balls, which dry leisurely; then put them into the fire till they are red hot; take them out, and let them cool: this is the best *White* to garnish with, being ground with weak *Gum-water*. 2. The chief *Blacks* are, *Hartshorn burnt*, *Ivory burnt*, *Lamp-black*, *Charcoal*, *Sea-coal*, *Verditer burnt*, *Mummy burnt*. 3. The chief *Reds* are, *Carmine*, *Vermillion*, *Red Lead*, *Indian Lake*, *Native*, *Cinnabar*, *Red Cher*, *Yellow Cher burnt*, and *Indian Red*. 4. The chief *Greens* are, *Green Pice*, *Green Pink*, *Verdigrise*, *Pecher*, *Sey*.

green, and Pink mixed with Bice. The chief Yellows are, *Orpiment*, *Masticote* deep and light, *Saffron*, *Pink-yellow* dark and light, *Oker-de-luce*, *English Oker*, *Roman Oker*, and *Gall-stone*. 6. The chief Blues are *Ultramarine*, *Indigo*, *Smalt*, and *Blue Bice*. 7. The chief Browns are, *Umber*, *Spanish Brown*, *Cologn Earth*, *Gall-stone*, rust of Iron, and *Mummy*.

This is to be noted, that, of the colours before-named, *Vermillion*, *Verdigrease*, *Orpiment*, and some others, are too coarse and gritty to be used in Water-colours, unless they be purified and prepared; and *Turnsole*, *Litmos Blue*, *Roset Brasil*, *Logwood*, and *Saffron*, are more fit for washing prints than curious limning.

Colours in painting, is a term applied to both the drugs, and the tints produced by those drugs, variously mixed and applied. Painters reduce all the colours they use under these two classes, Dark and Light Colours. Dark colours are *Black*, and all others that are obscure and earthy, as *Umber*, *Bistre*, &c. under light colours are comprehended *White*, and all those that approach nearest it.

Painters also distinguish colours into simple and mineral: under simple colours they rank all those which are extracted from vegetables, and which will not bear the fire; as the yellow made of *Saffron*, *French Berries*, *Lacca*, and other tinctures extracted from flowers, used by limners, &c.

The mineral colours are those which are drawn from metals, &c. and which are able to bear the fire; used by enamellers. Colours are also divided, by some, into changeable and permanent: changeable colours are such as depend on the situation of the objects with respect to the eye, as that of a Pigeon's neck, *Tafeta*, &c. the first however being attentively viewed with a microscope, each fibre of the feather appears composed of several little squares, alternately red and green; so that they are fixed colours. KIRCHER says, that the changeable colour observe

in the wings of Pigeons, Peacocks, &c. arises from the feathers being transparent, and of a figure resembling a prism; and, consequently, the lights being differently refracted from them. Permanent colours are not exhibited by refraction, but by reflection.

Particular Colours.

Cerufs.—Grind it with glair of Eggs, and it will make a very good *White*: it is too yellow for some purposes, coarse and gritty. *Spanish White*, being ground with Gum-water, is the best *White* of all to garnish with.

White Lead—Grind it with a weak water of *Gum Lake*, and let it stand three or four days, and, if it be afterwards mixed with *Roset* and *Vermilion*, it will make a fair *Carnation*.

Lamp-black.—It makes a good *Black*, being ground with Gum-water.

Vermilion.—If it be ground with the glair of an Egg, and a little clarified Honey, to make it bright and perfect, is good; but *Native Cinnabar* is better, and of a more lively colour. *Cinnabar Lake* makes a deep and beautiful *Red*, or rather *Purple*, almost like a red rose; grind it with *Gum Lake* and *Turnsole-water*; if you will have it light, add a little *Cerufs*, and it will make it a bright *Crimson*; if it be to diaper, add only *Turnsole-water*.

Red Lead.—Grind it with some *Saffron* and a stiff Gum-water; the *Saffron* will make it orient and of a *Marigold* colour.

Turnsole.—Lay it in a saucer of Vinegar, and set it over a chafing-dish of coals; when it boils, take it off, and wring it into a shell, adding a little *Gum Arabic*; let it stand till it is dissolved; this is good for shadowing *Carnations* and all *Yellows*.

Roset.—Grind it with Brasil-water, and it will make a deep Purple; put Ceruse to it, and it will be lighter; and it will make a fine Violet.

Green Dice.—Is to be ordered as you do Blue Dice; when it is moist and not thorough dry, you may diaper with the water of a deep Green.

Orpiment, Arsenicum, Auspimentum.—Grind it with a stiff water of Gum Lake, because it is the best colour itself; it will lie upon no Green, for all Greens, White and Red Lead, and Ceruse, stain it; wherefore you must deepen your colours so, that the Orpiment may be highest, and so as it may agree with all colours.

Massicote.—Grind it with a small quantity of Saffron in Gum-water, and never make it lighter than it is; it will endure to lie upon all colours and metals.

Saffron.—Steep it in glair, it may be ground with Vermilion.

English Oaker.—It is a Yellow colour, and lies even in the shell of itself: it is of great use being well ground.

Cherry-stone.—Is burnt in a crucible, and ground. It is good for Drapery, and for a black Sartin; temper it with a little white Indian Lake and Indigo: heighten it with a little lighter mixture; deepen it with Ivory-black.

Caput Mortuum of Vitriol.—First grind it well upon a Marble; then wash it well, and grind it with a weak Gum-Lake-water; it will make a deep Red or almost a Purple colour.

Spanish Brown.—Grind it with Brasil-water, mingle it with Ceruse, and it will make a Horse-flesh colour. It is not so brisk and lively as Indian Red.

Bole Armoniac.—Makes but a faint colour; the chief use of it is in making Size for burnished Gold.

Verdigrise.—Grind it with juice of Rue and a little weak Gum-water, and you will have a most pure Green; if you would diaper with it, grind it with

Ley of *Rue*, or the Decoction thereof, and it will make a hoary *Green*. Diaper upon *Verdigrease-green* with *Sap-green*. *Verdigrease*, ground with *White Tartar*, and then tempered with *Gum-water*, gives a most perfect *Green*.

Verditer.—Grind it with a weak *Gum-Arabic-water*; it is the faintest *Green* that is, but is good to lay upon *Black* in any kind of Drapery.

Sap-Green.—Lay it in sharp *Vinegar* all night, put into it a little *Allum* to raise its colour, and you will have a good *Green* to diaper with upon other *Greens*.

Pink-Yellow.—If you would have it sad-coloured, grind it with *Saffron*; if light with *Cerufs*; mix it with *Gum-water*, and so use it.

Oker-de-Luce.—Grind it with pure *Brasil-water*, and it will make an excellent *Hair-colour*, and is a natural shadow for *Gold*; *Roman Oker* is the most glowing *Oker* of all.

Umber.—Is a sad *Prown* colour; grind it with *Gum-water* or *Cum Lake*; and lighten it if you please, with a little *Cerufs* and a blade of *Saffron* to cleanse it; burn it in a crucible, then grind it and it will be good; and when you temper it in the shell, use a drop or two of *Onion-water*, and it will preserve it from cracking.

Ultramarine.—If you would have it deep, grind it with *Litmas-water*, but if light, with fine *Cerufs*, and a little *Gum Arabic* water. In grinding *Ultramarine* and other colours, be not too swift in your motion; but let it be gentle and slow, which will cause your colour to starve, or lose somewhat of its lustre, especially, if it be a colour of no great body, as *Pink*, *Indigo*, &c.

Blue Vice.—Grind it with clean water, as fine as can be, and then put it into a shell, and wash it as follows; put as much water to it as will fill up the shell or vessel you put it into, and stir it well; let it stand for an hour, then throw away the filth and di-

ty water, and put in more clean water; do this 4 or 5 times; then put some weak *Gum Arabic* water to it, that the *Bice* may fall to the bottom; pour off the *Gum-water*, and put more to it; wash it again, dry it and mix it with weak *Gum-water*, if you would have it rise of the same colour; but with a stiff water of *Gum Lake*, if you would have a most perfect *Blue*; but grind it with a little *Cerufs*, if you would have it a light *Blue*; if you would have it a very deep *Blue*, add *Litmos-water*.

Smalt.—Grind it with a little fine *Rosetta*, and it will make a deep *Violet*, and by putting in a quantity of *Cerufs* it will make a light *Violet*.

Litmos Blue.—Grind it with *Cerufs*, with a pretty deal of *Litmos*, it will make a deep *Blue*, and with a deal of *Cerufs*, it will make a light *Blue*; grind it with the weak water of *Gum Arabic*. Take fine *Litmos*, cut it in peices, lay it in weak water of *Gum Lake* for twenty-four hours, and you will have water of a most perfect *Azure*; with which water you may diaper and damask upon all other *Blues*, to make them appear more fair and beautiful.

Orchal.—Grind it with unslacked *Lime* and *Urine*, it makes a pure *Violet*; by putting to it more or less *Lime*, you make the *Violet* light or deep as you please.

Mummy.—Makes a good *Black*, but is commonly ill-conditioned, hard, and will flow from the pencil till burnt in a crucible well luted.

Ivory-black.—Grind it with a little white *Sugar-Candy* and it will preserve it from cracking out of your shells; it makes a good *Black*.

Pink.—Mixed with *Blue Bice*, makes good *Green*; the fairest *Pink* is best, well ground and tempered with *Blue Bice*, allowing one quantity of *Pink* to three of *Blue Bice*. If you would deepen it for Landscapes or Drapery, mix a little *Indigo* finely ground with it.

Indian Lake.—This makes a delicate *Purple*; grind it with a little *Gum-water*, and when it is fine, be-

fore you put it into the shell, mix a little powder of white *Sugar-Candy* with it, which will preserve it from cracking; then you may spread it thinly with your finger about the shell.

Indian Red—Makes a very dark *Red*; because this colour is very coarse, you may use *Umber* and a little *Lake* tempered, which is very good.

Caput Mortuum of Vitriol.—First grind it well up on a *Marble*; then wash it well, and grind it with a weak *Gum Lake* water; it will make a deep *Red*, or almost *Purple* colour.

Observations on Mineral Colours

1. *Sublimate*.—Dissolved in fair water, and mixed with a little *Spirit of Urine*, makes a good *Milk-White* mixture in a moment; which by an addition of *Aqua fortis*, becomes transparent again immediately.

2. If you sublime together two ounces of *Sublimate*, and one ounce of *Tin-Glass*, you will have a *Sublimate* not inferior to the best orient *Pearls* in the world. *Mercury Sublimate* and *Precipitate* yield, with the *Spirit of Urine*, *Hartshorn*, or the like, *White Precipitate*; but with the solution of *Pot Ashes*, or other lixivate Salts, an *Orange Tawny*.

3. Fine powers of *Blue Bice* and *Yellow Oximent*, slightly mixed, produce a good *Green*; and a high yellow solution of a good *Gold* in *Aqua Regia*, mixed with a due quantity of a deep *Blue* solution of crude *Copper* in *Spirit of Urine*, produces a transparent *Green*; and so *Blue* and *Yellow Enamels* fused together in the flame of a lamp, being strongly blown on without ceasing, produces at length a *Green* colour.

4. *Verdigrease*.—Ground with *Sal Armoniac*, and the like, digested for a while in a *Horse dung-hill*, makes a glorious *Blue*; and *Spirits of sal Armoniac* makes the solution of *Verdigrease* an excellent *Blue*.

5. *Quicksilver*.—Mixed with three or four times its weight of good *Oil of Vitriol*, and the oil drawn off in sand, through a glass retort, leaves a snow-white *Precipitate*, which, by the effusion of fair water, becomes one of the loveliest light *Yellows* in the world, and is a durable colour.

Lastly, good *Vermillion* is made of *Mercury* and *Brimstone*, sublimated together in due proportion.

Observations on Vegetable Colours.

1. A Decoction of *Red Roses*, dried in fair water, mixed with a filtrated Solution of *Blue Vitriol*, makes a *Black Colour*; and this being mixed with a little *Aqua Fortis*, turns it from a *Black* to a deep *Red*; which by the affusion of a little *Spirits of Urine*, may be presently reduced to a thick and black colour.—

2. Syrup of *Violets* mixed with a little juice of *Lemons*, *Spirit of Salt*, *Vinegar*, or the like *Acid Salt*, will immediately become red; but mixed with *Oil of Tartar*, or a Solution of *Potashes*, will in a moment become a perfect *Green*; and the like in the juice of

Blue Bottles.—3. *Tincture Cochineal*, dilated never so much with fair water, will never yield a *Yellow Colour*. A single drop of a deep Solution in *Spirit of Urine*, dilated in an ounce of fair water, makes a fair *Pink* or *Carnation*.—4. Infusion of *Logwood*, in fair water, mixed with *Spirit of Sal Armoniac*, immediately turns into a deep, rich, lovely *Purple*.—

5. The juice of *Privet Berries*, with *Spirit of Salt*, is turned into a lovely *Red*, but with a strong Solution of *Potashes*, into a delightful *Green*.—A few grains of *Cochineal*, being mixed with the *Liquor* of *Quick Lime* in a due proportion, makes a fading *Purple* colour of the greatest glory imaginable.

7. *Spirits of Sal Armoniac* will turn Syrup of *Violets* to a lovely *Green*.—8. Infusion of *Elemis* in fair water will, in a clear glass, give a *Purple Colour*; but

will be wholly chang'd into a glorious yellow, by spirit of Salt being added.

It has not been yet found, that, to exhibit the strong variety of Colours, there is need that any more than these five be applied, viz: *White, Black, Red, Blue, Yellow*; for these being variously compounded, exhibit a variety and number of colours: So many, that those who are strangers to painting, can hardly imagine. So *Black* and *White*, variously mixed, make a vast company of light and deep *Greys, Blue* and *Yellow*, a great variety of *Greens*; *Red* and *Yellow* several *Orange Tawnies*; *Red* and *White* a number of *Carnations*; *Red* and *Blue*, several *Purples*, and thus are many colours produced, for which we want names.

Of preparing Colours.

Colours according to their nature, have each a particular way of proportion, viz: by grinding, washing, or steeping. The chief colours to be ground are, *White Lead, Ceruss, Cinnabar, Lake, Oker yellow and brown, Pink, Indigo, Umber, Cologn Earth, Spanish Brown, Ivory-black, Cherry-stone-black, Lamp-black, Indian red, and Indian Lake*.—The chief colours to be wash'd are, *Red Lead, Masticote, Green Bice, Cedar Green, Ultramarine, Blue Bice, Smalt, and Verditer*. The chief colours to be steeped are, *Sap Green, Saffron, Turnsole, Stone Blue, and French Berries*.

The Method of grinding Colours.

Take the colour you would grind, and scrape off from it all the filth; then lay it upon the stone, and with the muller, bruise it a little, then put to it a

little spring or weak Gum-water, and grind them altogether very well, till the colour is very fine; which done, pour it out in certain hollows or furrows cut in chalk stone, and there let it lie till it is dry, which preserve in paper or glasses. Take care in grinding your colours not to put too much water to them, upon the stone, for they ought to be ground pretty thick like pulp or pap; and they ought not to be left too moist, but thick and clammy. If after your colour is dry in the shell, you can rub it off with your fingers, it must be better bound with gum; and, if there be too much gum, it will shine, and be apt to crackle off after it is used.

Of mixing and compounding Colours.

An *Ash Colour*, or Grey, is made by mixing White and *Lamp-black*, or White with *Sinapu*; *Indigo* and Black make an *Ash Colour*.—To make an *Azure* or *Blue*: Mix the *Azure* with *Glue Water*, and not with *Gum Water*.—A *Bay Colour*: Mingle *Vermillion* with a little *Spanish Brown* and Black. A *Bright Crimson*: Mix Tincture of *Brazil* with a little *Cerufs* ground with fair water.

To make a *Crimson Lake*: It is usually made of the flocks shorn off from crimson cloth, by a Ley made of *Salt Petre*, which extracts the colour; which precipitate, edulcorate, and dry in the sun, or in a stove.—To make a *Sad Crimson*: Mix the aforesaid light *Crimson* with a little *Indigo*, ground with fair water.—To make a *Flame Colour*: It is made of *Vermillion* and *Orpiment*, mixed deep or light at pleasure: or thus: Take *Red Lead*, and mix it with *Masticote*, which heighten with White.—To make a *Glass-Grey*: Mingle *Cerufs* with a little *Azure*.

To make excellent good GREEN.

The Liver of a *Lamprey* makes an excellent *Green*; and *Yellow* laid upon *Blue* will change into *Green*; so likewise the juice of *Blue Flower de lis*, mixed with Gum-water, will be a perfect and durable *Green* or *Blue*, according as it is used.—To make a *Light Green*: It is made of *Pink* or *Smalt* with *White*, to make it whiter if need require.—To make a *Lead Colour*: It is made of *White Lead*, mixed with *Indigo*.

To make a FLESH-COLOUR.

Mix a little *Lake* and *Red Lead* with *White*, a very small quantity of each; you may make it as light or as red as you please, by putting more or less *White* in it. If you would have a swarthy complexion to distinguish a man's flesh from a woman's, put a little *Yellow Oker* among your *Flesh Colour*; and for your *Shadow*, put a little more *Lake*, and a small quantity of *burnt Umber*.

To make a MURREY.

Which is composed of *Purple* and *White*: it is made thus: take *Cinnabar Lake* two ounces; *White Lead* one ounce; and grind them together.

To make good MURREY.

Temper *Rozin* with a little *Rose Water*, in which a little *Gum* hath been dissolved, and it will be good, but not better than the first.

To make pure LAKE.

Take *Urine* ten pounds, boil it in a kettle, and skim it with an iron skimmer, till it comes to eight pounds; to which add *Gum Lake*, half a pound; *Alum*, two ounces and an half; boil it all till it is

well coloured, which you may try by dipping a piece of linen cloth into it; then add *Roche Alum* in powder, a sufficient quantity. Strain it, and let it stand; strain it again through a cloth, till the liquor be clear; that which remains in the cloth or bag is pure *Lake*.

To make a deep PURPLE.

This is made of *Indigo*, *Spanish Brown* and *White*. To make another *Purple*: Boil *Logwood* in *Vinegar* and *Beer*, in a glazed earthen vessel, adding thereto a little *Allum*, till you taste it to be strong on your tongue; when it is sufficiently boiled, strain out the liquor through a cloth, and keep it in a glass close stopped for use.

To make a YELLOW, GREEN, or PURPLE.

Buckthorn Berries gathered green, steeped in *Alum Water*, yield a good *Yellow*; but being thorough ripe and black, they yield a good *Green*: and lastly, being gathered when they are ready to drop off, which is about the middle or end of November, their juice mixed with *Alum Water*, yields a good *Purple Colour*.

To make a PEAR GREEN.

Take white *Tarter* and *Verdegrease*, temper them with strong *White Wine Vinegar*, in which a little *Gum Arabic* has been dissolved.

To make CLOUD COLOURS.

You may sometimes take *Blue Verditer*, sometimes light *Masticote* shadowed with *Blue Verditer*, or *Lake* and *White*, or *red Ink* and *White*, shadowed with *Blue Verditer*.

To make a Red COLOUR.

Take the roots of the Lesser *Dragon*, and *Alkanet*, and beat them, and strain out the juice, and mix it with *Alum Water*.

To make a SCARLET COLOUR.

It is made of Red Lead, Lake, and Vermillion; yet in this case Vermillion is not very useful.

To make VERMILLION.

Take Brimstone in powder, four ounces; mix it with Quick-silver, a pound; put it into a Crucible well luted, and upon a charcoal fire, heat it till it is red hot, then take it off, and let it cool.

A Saffron Colour is made of Saffron alone, by Infusion.

To make a YELLOW.

Take the Yellow Chives in White Lillies, steep them in Gum-water, and they will make a perfect Yellow; the same from Saffron and Tartar tempered with Gum-water.

To make a pure PURPLE COLOUR.

Take fine Brimstone, an ounce and a half; Quick-silver, Sal Armoniac, and Tin, of each one ounce; pulverise the Salt and Brimstone, and make an Amalgama with the Quick-silver and Tin; mix all together, which put into a great glass gourd; make under it an ordinary fire, and keep it in a constant heat for the space of six hours.

Tempering Colours.

Take a little of any colour, and put it in a clean shell; add to it a few drops of Gum-water, and with your finger work it about the shell, let it dry, and when dry touch it with your finger; if any colour comes off, you must add stronger Gum-water; but being dry, if the colour glister or shine, it is a sign there is too much Gum in it, which you may remedy by putting in fair water.

To help the Defect of Colours.

Some Colours as *Lake*, *Umber*, and others which are hard, will crack when they are dry; in this case, in tempering them, add a little *White Sugar Candy* in very fine powder; which mix with the colour and fair water, in the shell, till the *Sugar Candy* is dissolved.

To burn or calcine Colours.

This is to be done in a crucible, covering the mouth of it with clay, and setting it in a hot fire, till you are sure it is red hot through; which done, being cold, wash or grind them.

To prepare Shadows for Colours.

White is shaded with *Black*; and contrarywise, *Yellow* with *Umber* and the *Okers*; *Vermillion* with *Lake*; *Blue Bice* with *Indigo*; *Black Coal* with *Roset*, &c.

To wash Colours.

Put the Colour into a glazed vessel, and put fair water to it plentifully; wash it well, and decant, after awhile, the water; do this six or seven times; at last put the water, being just troubled, into another glazed vessel, leaving the dregs at bottom; then into this second vessel put more fair water, washing it as before, till the water, being settled, be clear, and the colour remain fine at the bottom. Before you take the colour out of the vessel, spread it very thin about the sides thereof, and when it is dry, some of it will fall to the bottom, which keep by itself; but the remainder which sticks to the sides of the basin is the best of all, which with a feather, strike off from the sides of the vessel, for it will be finer than any flour.

Steeping Colours.

Take a quantity of the colour, put it into a shell, and fill the shell with fair water, to which add some fine powder of *Allum*, to raise the colour; let it thus steep a day and night, and you will have a good colour. *Saffron* steeped in *Vinegar* gives a good colour; and the *French Berries*, in fair water, and a little *Allum*, or a drop or two of Oil of *Vitriol*, makes a *Yellow*. But some colours are to be boiled as *Brazil*, *Logwood*, *Turnsole*, rinds of *Walnuts*, *Woodsoot*, &c. These when boiled, are to be kept close stopped in Glasses till you have occasion to use them.

Instruments necessary.

1. The Easel; 2. the Pallet; 3. the Straining Frame; 4. the Priming Cloth; 5. the Pencils; 6. the Stay.

The Easel is a frame made of wood much resembling a ladder, with flat sides and full of holes, to put in two Pins to set the Straining Frame and Cloth upon, either higher or lower at pleasure, being something broader at the bottom than at the top; on the backside of which is a Stay, by which the Easel may be set either more sloping or more upright.

The Pallet is a thin piece of wood, either of Pear or Walnut tree, about a foot in length and ten inches in breadth, in almost an oval form, at the narrow end of which is a hole to put in the thumb of the left hand, near which there is a notch cut, that the paller may be held in the hand: the use of this is to hold and temper the colours upon.

The Straining Frame is made of wood, on which the primed Cloth that is to be painted upon is fastened with nails: these frames ought to be of several sizes, according to the size of the cloth.

The Primed Cloth is that which is to be painted upon, and is to be prepared as follows: take good Canvas, and first smooth it over with a flect Stone, size it over with good Size and a little Honey, and let it stand to dry; then lay it over once with Whiting and Size, mixed with a little Honey, and the cloth is prepared: the use of the Honey is to prevent it from cracking, peeling, or breaking out.

Pencils of different sizes are requisite in Painting from the thickness of a pin to that of two inches diameter, which are called by several names; as *Dutch Quill* fitched and pointed, *Goose Quill* fitched and pointed, *Swan Quill* fitched and pointed, *Jewelling Pencils*, and *Bristle Pencils*, some in Quills, some in *Tin Cases*, and some in Sticks.

The Stay, or Moltic, is a Stick, generally of Brasil wood, in length about a yard, having a small ball of Cotton at one end of it, fixed hard in a piece of Leather, about the size of a Chesnut, which is to be held in the left hand while you are working; and laying the end which hath the leather ball upon the cloth or frame, you may rest your right arm upon it.

Colouring in Painting.

Colouring, in its general sense, takes in what relates to nature and union of colours; their agreement or antipathy; how to use them to advantage in light and shadow, so as to shew a *Relievo* in the Figures, and a sinking of the Ground. What relates to Aerial Perspective, that is the diminution of colours, by means of the interposition of air; the various actions and circumstances of the Luminary and the Medium; the different lights both of the bodies illuminating, and illuminated; their reflections, shadows, different views, either with respect to the position of the eye or object: what produces the

strength, fierceness, sweetness, &c. in Paintings well coloured, is the various manners of colouring both in Figures, Landscapes, &c. The doctrine of Colouring is comprised under the following rules: Colours are considered either in respect of their use, or their economy and disposition.

First, in respect to their use: they are applied either in oil or water; those in oil, again, are considered with a view either to their preparation or application. In the preparation of Oil colours, care must be taken that they be ground fine; that, in putting them on the Pallet, those which will not dry of themselves be mixed with Drying Oil, or other ingredients of a drying quality, and that the tinged colours be mixed in as small quantities as possible. For their application, it is considered either in respect to the kinds of painting in works of various colours, or in those of one single colour. For the first in the larger pieces, the colours are either laid on full, so as they may be impasted, or incorporated together, which makes them hold the more firmly; or else the more agreeable ones are mixed, which dry too hard and hastily, with a little colour, and the clearest of the oil; but in both cases the colours are to be laid on strongest at first, it being easy to weaken those that are to be thrust back, and to heighten others; the touches to be bold by the conduct of a steady pencil, that the work may appear the most finished at a proper distance, and the figures animated with life and spirit.

As to Glazed Colours, care is to be taken that the under colours be painted strong, and that it be a body colour and laid smooth. In finishing works, which are to be viewed near at hand, they proceed either by applying each colour in its place, preserving their purity without fretting or fermenting them, but sweetly softening all their extremities; or by filling up all the great parts with one single colour, and

laying the other colours which are to form the little things upon it, which way is the more expeditious, but the most apt to decay.

For the second, the kinds of pictures in one colour are two, where the degradations of colours of objects afar off are usually managed by lights, as with Crayons and Basso-Relievo; which is an imitation of Sculpture of whatsoever matter and colour; in both these the colours are wrought dry. As for Water Colours, they are wrought various ways, viz. in Distempers, where the colours are prepared in Size, which method is used on all kinds of matter, in Fresco or Painting on fresh Mortar; where the colouring must be quick, that the matter dry not, and with much care and neatness laying each colour in its place, and intermingling them by parcels. In Agouache, where the colours are mixed with Gum, and the pencil dragged as in Paintings and Washings. In Miniature, or small and delicate works, where the colours are to be very fine and clean, mixed with Gums and wrought with Dots or Points; but in all kinds of paintings, both in Oil and Distemper, especially the latter, care must be taken that the design be fixed, and all the parts marked out, before any colours be applied.

2. But in the second part of Colouring, or the economy and dispensing thereof in Paintings regard is had, either first to the quality of the colours, to appropriate them according to their value and agreement; or, secondly, their effect and economy of the works: as to the first it must be observed, that *White* represents Light, and gives the brillkness and heightening; on the contrary, *Black*, like Darkness, obscures and effaces the object; again, *Black*, sets off the light parts, and by that they serve each other to loosen the objects. A proper choice is to be made of colours, and the too much charged manner, is to be avoided, both in Carnations, where red colours are not to be affected, as rather resembling the flesh.

when Head, than the skin; and also in all bright glowing colours; the skin how delicate soever, being of a Down colour. Also in the Drapery, where the painter has his whole stock of colours to chuse out to procure a good effect, and in the Landscape to dispose of those colours near one another, which mutually assist and raise each other's force and briskness; as *Red* and *Green*, *Yellow* and *Blue*.

As to the effects of colours, they either have relation to the union or the economy; with respect to the first, care must be taken, that they be laid so as be sweetly united under the briskness of some principal one; that they participate of the prevailing light of the piece, and that they partake of each other by the communication of light and the help of reflection.

As for the economy in managing their degrees, regard is to be had to the contrast or opposition intervening in the union of the colours; that by a sweet interruption, the briskness which otherwise fades and palls, may be raised to the harmony which makes the variety of colours agree; supplying and sustaining the weakness of some by the strength of others; neglecting some places to serve as a basis or repose to the light, and to entrance those which are to prevail through the piece. As to the degradation, where, the better to proportion the colours that fall behind, some of the same kind are to be preserved in their purity, as a standard for those carried afar off to be compared by, in order to justify the diminution; regard being always had to the quality of the air, which, when loaded with vapours, weakens the colours more than when clear. Relative to the Situation of Colours, care must be taken, that the purest and strongest be placed before or in the front of the piece; and that compound ones, which are to appear at a distance, be kept

back by their force ; the glazed colours particularly to be used in the first rank.

Colours are to the eye, what sounds are to the ear, tastes to the palate, or any other objects of our senses, are to those senses ; and accordingly, an eye that is delicate, takes in proportionable pleasures from beautiful ones, and is as much offended with their contraries. Good colouring therefore in a picture is of consequence, not only as it is a truer representation of nature, where every thing is beautiful in its kind ; but as administering a good degree of pleasure to the sense. The colouring of a picture must be varied according to the subject, the time, and place : If the subject be grave, melancholy, or terrible, the general tint of the colouring must incline to *Brown, Black, or Red* and gloomy ; but you must be gay and pleasant in subjects of joy and triumph.

Morning, Noon, Evening, Night, Sunshine, wet and cloudy Weather, influences the colours of things ; and, if the scene of the picture be a room, open air, partly open and partly inclosed, the colouring must be accordingly. The distance also alters the colouring, because of the medium of air through which every thing is seen, which being *Blue*, the more remote any object is, the more it must partake of that colour, and of consequence must have less force or strength : the Ground therefore, or whatsoever is behind a Figure, for example, must not be so strong, as that figure is, nor any of its parts which round off as those that come nearer to the eye ; and that not only for the reason already given, but because there will always be reflections, stronger or weaker, that will diminish the force of the shadows, which reflections, by the way, must partake of the colours of those things from whence they are produced.

Any of the several species of colours may be as beautiful in their kinds as others; but one kind is more so than another, as having more variety, and consisting of colours more pleasing in their own nature; in which harmony and agreement of one tinct with another, the goodness of Colouring consists. To shew the beauty of variety, we will instance in a Gelder Rose, which is white, but having many leaves one under another, and lying hollow, so as to be seen through in some places, which occasions several tincts of light and shadow; and with these, some of the leaves having a greenish tinct, altogether produces that variety, which gives a beauty not to be found in this paper though it is white; nor in the inside of an Egg shell, though whiter; nor any other object, that has not that variety. And this is the case, though this flower be seen in a room, in gloomy or wet weather, but let it be expos'd to the open air; when the sky is serene, the *Blue* that those leaves or parts of leaves, that lie open to it, will receive, together with the reflections that then will also happen to strike upon it, will give a great addition to its beauty: but let the sun beams touch up its leaves, where they can reach with their fine yellowish tinct, the other retaining the Sky blue, together with the shadows and brisk reflections it will then receive, and then you will see what a perfection of beauty it will have; not only because the colours are more pleasant in themselves, but there is greater variety. A Sky entirely blue would have less beauty than it has, were it not always varied towards the horizon, by the sun beams, whether rising, setting, or in its progress; but neither has it that beauty, as when more varied with Clouds, tinged with *Yellow*, *White*, *Purple*, &c.

A piece of Silk or Cloth, hung or laid flat, has not the beauty, though the colour of it be pleasing, as when flung into folds; nay, a piece of Silk that

has little beauty in itself, may be much improved only by being pinked, watered, or quilted: the reason is in these cases there arises a variety produced by lights, shades, and reflections. There are certain colours less agreeable than others, as a Brick wall, for example; yet, when the Sun strikes upon one part of it, and the Sky tinges another part of it, and the shadows and reflections the rest, this variety shall give even that a degree of beauty. Perfect *Black* and *White* are disagreeable, for which reason, a painter should break those extremes of colours, that there may be a warmth and mellowness in his work; let him, in *Flesh* especially, remember to avoid the Chalk, the Brick, and Charcoal, and think of a *Pearl* and a ripe *Peach*.

But it is not enough, that the colours in themselves are beautiful singly, and that there is variety, they must be set by one another, so as to be mutually assistant to each other; and this not only in the object painted, but in the ground, and whatsoever comes into the composition, so that as every part, and the whole together, may have a pleasing effect to the eye, such a harmony to it as a good piece of music has to the ear; for which no certain rules can be given, no more than for the latter, except in some few general cases, which are very obvious, and need not therefore be mentioned here.

The best that can be done, is to advise one who would know the beauty of colouring, to observe Nature, and how the best Colourists have imitated her. What a lightness, thinness, and transparency, what a warmth, cleanness, and delicacy, is to be seen in good pictures! he that would be a good colourist himself, must moreover practice much, and for a considerable time accustom himself to see well-coloured pictures only; but even this will be in vain, unless he has a good eye in the senses, as one is said to have a good ear for music: he must not only see

well, but have a particular delicacy with relation to the beauty of colours, and the infinite variety of tincts.

The various Forms and Degrees of Colouring.

There are four various forms or degrees of colouring, viz.

1st. Of Infants or Children.

2d. Virgins or fair Women.

3d. Naked Bodies.

4th. Old or aged Bodies.

1st. Infants or young Children are to be painted of a soft and delicate complexion, the skins and ears of a ruddy and pleasant colour, almost transparent. This may be done with *White Lead*, *Lake*, and a little *Red Lead*, shadowing it thin, faint and soft, letting the Cheeks, Lips, Chin, Fingers, Knees, and Toes, be more ruddy than the other parts; making all their linen, very fine, thin, and transparent, or perspicuous, with strong touches in the thickest folds.

2d. Virgins and fair Women are as curiously to be expressed as the former; but their muscles ought to appear more plainly; their shapes more perfect, and their shadows to be of a whitish yellow, bluish, and in some places almost *Purple*; but the most perfect and exquisite direction is the life, which ought rather to be followed, than any thing delivered by rule: for the shadows here, mix *White* with *Pink*, and *Indigo* and *White*; and in some places *Lake*, with a little *Indigo* and *White*. As for Women's bodies, viz. such as are naked, they are to be represented soft, round, plump, gentle and tender, and without muscles: on the contrary, the bodies of Men are to

be represented strong, sturdy, stout, and vigorous, with the muscles exactly placed and strong; which to do with judgment and understanding, requires time, study, and knowledge in Anatomy.

3d. Naked Bodies are to be painted strong, lively, and accurate, exactly matching the respective pairs of muscles and nerves, fixing each artery in its due and proper place, giving each limb its proper motion, form, and situation, with its true and natural colour; all which to do well may be the study and practice of almost one's whole life.

4th. Old or aged bodies ought to be eminent for exact and curious shadows, which may be made of *Pink, Lake, Ivory Black*, which make very proper shadows in appearance, like the wrinkles and furrows of the face and hands in extreme old age. Let the Eyes be dark, the Aspect melancholy, and Hair white, or else the Pate bald, and all the remarks of antiquity or age be very apparent. *Pink* mixed with *Lake* and *Red Lead* make an excellent shadow for the bodies of old Men; but for the extremest or deepest shadows, either in the Face or Body, mix *Lake* and *Ivory Black*, which will make an excellent deep shadow, and will be very useful in expressing the several furrows and wrinkles in the face and hands of very old people, with their dark eyes and melancholy aspects: but notwithstanding all the foregoing rules, the posture or form of standing, and being, either of the whole body, or any of its parts, ought to be diligently observed, that the life may be imitated.

Composition.

Composition, is putting together, for the advantage of the whole, what shall be judged proper to be the several parts of a Picture; either as belonging to it, or because they are thought necessary for the common

benefit: and moreover, the determination of the painter, as to certain attitudes and colours, which are otherwise indifferent.

The Composition of a picture is of vast consequence to the goodness of it: it is what first of all presents itself to the eye, and prejudices us in favour of, or with an aversion to it: it is this that directs us to the ideas that are to be conveyed by the painter, and in what order; and the eye is delighted with the harmony at the same time the understanding is improved: whereas this being ill, though the several parts are fine, the picture is troublesome to look upon, and like a book, in which are many good thoughts, but flung in confusedly, and without method.

Every picture should be so contrived, as that at a distance, when one cannot discern what figures there are or what they are doing, it should appear to be composed of masses light and dark; the latter of which serve as repotes to the eye. The form of these masses must be agreeable, of what ever they consist, Ground, Trees, Draperies, Figures, &c. and the whole together should be sweet and delightful; lovely shapes and colours, without a name; of which there is an infinite variety: and it is not enough that there be great masses; they must be subdivided into lesser parts, or they will appear heavy and disagreeable; thus, though there is evidently a broad light (for example) in a piece of Silk, when covering a whole figure, or a limb, there must be lesser folds, breakings, flickerings, and reflections, and the great mass yet evidently preserved. Sometimes one mass of light is upon a dark ground, and then the extremities of the light must not be too near the edges of the picture, and its greatest strength must be towards the centre; as in the descent from the Cross, and the dead Christ, both of RUBEN'S, and of both which there are prints, one by VOSTERMAN, and the other by PONTIUS.

There is a Painting of the Holy Family, by RUBENS, of this structure; where because the mass of light in one part, would else have gone off too abruptly, and have made a less pleasing figure, he has set the foot of St. Elizabeth on a little stool: here the light catches, and spreads the mass so as to have the desired effect. Such another artifice RAPHAEL has used in a Madona; he has brought in a kind of ornament to a Chair, for no other end (as may be imagined) but to form the mass agreeably. VAN DYKE, that he might keep his principle light near the middle of this picture, and to advantage the body, which he seems to have intended to exert himself in, has even kept the head sombrous in an *ecce homo*, and makes the whole have a fine effect.

The same author says, he has many times observed with a deal of pleasure the admirable composition (besides the other excellencies) of a fruit tree of MICHAEL ANGELO-CAMPADOGGIO, the principal light is near the centre, (not exactly there, for those regularities have an ill effect) and the transition from thence, and from one thing to another, to the extremities of the picture all round, is very easy and delightful; in which he has employed fine artifices by Leaves, Twigs, little touches of lights striking advantageously, and the like; so that there is not a stroke in the picture without its meaning; and the whole, though very bright, and consisting of a great many parts, has a wonderful harmony and repose.

Sometimes the structure of a picture, or the *Tout-ensemble* of its form, shall resemble dark clouds on a light ground. There are instances where two masses, a light and a dark one, divide the picture, each possessing one side: of this sort is one done by RUBENS, and as fine a composition as can be seen; the masses are so well rounded, the principal light being

near the middle of the bright one, and the other having subordinate lights upon it, so as to connect, but not to confound it with the rest; and they are in agreeable shapes, and melting into one another, but nevertheless sufficiently determined.

Very commonly a picture consists of a mass of light and another of shadow upon a ground of middle tinct: and sometimes it is composed of a mass of dark at the bottom, another lighter above that, and another for the upper part still lighter; (as usually in a Landscape) sometimes the dark mass employs one side of the picture also: as a certain copy after PAOLO VERONESE, where is a large group of figures, the principal ones of the story compose the lower brown mass; Architecture, the second; more buildings, with Figures and the Sky, the third; but most commonly, in pictures of three masses, the second is the place of the principal figures.

Of such consequence are these agreeable masses in a picture, that for the sake of them, what is less material must be dispensed with, when both cannot be had: as the principal figure and action must be distinguished, those limbs of a figure that are chiefly employed, ought to be made conspicuous.

As the *Tout-ensemble* of a picture must be beautiful in its masses, so it must be as to its colours; and, as what is principal must be (generally speaking) the most conspicuous, the predominant colours of that should be diffused throughout the whole. This RAPHAEL has remarkably observed in the cartoon of St. Paul preaching; his Drapery is *Red* and *Green*, and these colours are scattered every where, but judiciously; for subordinate colours as well as subordinate lights, serve to soften and support the principal ones, which other wise would appear as spots, and consequently be offensive: and when the subject does not necessarily require a due variety or beauty of tinct; or perhaps the picture, when thought to be finished, is found to want something of this kind; a few *Red*

or *Yellow* leaves of trees, flowers of whatever colour, in short, any thing otherwise indifferent may be flung in very advantageously.

In a figure, and every part thereof, and indeed in every thing else, there is one part which must have a peculiar force, and be manifestly distinguished from the rest, all the other parts of which must also have a due subordination to it, and to one another: the same must be observed in the composition of an entire picture; and this principal, distinguished part ought (generally speaking) to be the place of the principal figure and action: and here every thing must be higher finished; the other parts must be less so, gradually.

In the descent from the Cross of RUBENS, the Christ is the principal figure: this body being naked, and about the centre of the picture, would have been distinguished as the heightening of this mass of light; but, not content with that, and to raise it still more, this judicious master has added a sheet, in which the body is, and which is supposed to be useful to deliver it down safely, as well as to carry it off afterwards; but the main design is what we are observing, and for that it is admirably introduced.

Sometimes the place in a picture, and not the force, gives the distinction; and sometimes the painter happens to be obliged to put a figure in a place, and with a degree of force, which does not sufficiently distinguish it: in this case, the attention must be awakened by the colour of its drapery, or a part of it, or by the ground on which it is painted, or some other artifice. *Scarlet*, or some vivid colour is very proper on such occasions. In a picture of *Albano*, which Sir JAMES THORNHILL had, our Lord is seen at a distance, as coming towards some of his Disciples; and though a small figure is nevertheless

the most apparent in the picture, by being placed on a rising ground, and painted upon a bright part of the Sky, just above the horizon.

In a composition as well as in any single figure, or other part of which the picture consists, one thing must contrast, or be varied from another. Thus, in a figure, the arms and legs must not be placed to answer another in parallel lines: in like manner, if one figure in a composition stand, another must bend, or lie on the ground; and of those that stand, or are in any other position, if there be several of them, they must be varied by the turns of the head, or some other artful disposition of their parts, as may be seen (for instance) in the cartoon of Giving the Keys. The masses must also have the like contrast, two must not be alike in form or size, nor the whole mass composed of those lesser ones of too regular a shape: the colours, must be also contrasted and opposed, so as to be grateful to the eye: there must not (for example) be two Draperies in one picture of the same colour and strength, unless they are contiguous, and then they are but as one. If there be two *Reds*, *Blues*, or whatever other colour, one must be of a darker or paler tinct, or be some way varied by lights, shadows or reflections. RAPHAEL, and others, have made great advantage of changeable Silks to unite the contrasting colours, as well as to make a part of the contrast themselves: As in the cartoon of Giving the Keys, the Apostle that stands in profile, and immediately behind St. John, has a *Yellow* garment with *Red* Sleeves, which connects that figure with St. Peter and St. John, whose draperies are of the same species of colours: then the same anonymous Apostle has a loose changeable drapery, the Lights of which are a mixture of *Red* and *Yellow*, the other parts are bluish: this unites it.

self with the other colours already mentioned; and with the *Blue* Drapery of another Apostle which follows afterwards; between which and the changeable Silk, is a *Yellow* Drapery, something different from the other *Yellows*, but with shadows bearing upon the *Purple*, as those of the *Yellow* Drapery of St. Peter incline to the *Red*; all which, together with several other particulars, produce a wonderful harmony.

Though a mass may consist of a number of little parts, there ought to be one, or more, larger, and as it were, governing the rest, and this is another sort of contrast. The good Samaritan, by BASSACE, is a fine instance of this: in the same picture, there are two Knees of two several figures, pretty near together, and the Legs and thighs of which make angles too much alike; but this is contrasted by one being naked, and the other clad: and over the latter a little sort of sash falls, which is an additional expedient.

There is also an admirable contrast in the cartoon of St. Paul preaching: this figure (which is a rare one) stands alone as he ought to do, and consequently is very conspicuous, which is also perfectly right: the attitude is as fine as can be imagined; but the beauty of this noble figure, and with it of the whole picture, depends upon this artful contrast we have been speaking of; of so great consequence is that little part of the Drapery flung over the Apostle's Shoulders and hanging down almost to his Waist; for (besides that it poises the figure, which otherwise would have seemed to have tumbled forwards) had it gone lower, so as to have, as it were, divided the outlines of the hinder parts of the figure in two equal, or near equal parts, it had been offensive; as it had been less pleasing, if it had not come so low as it does. This important piece of Drapery preserves the mass of Light upon that figure, but varies it, and gives it an agreeable form; whereas, without

it, the whole figure would have been heavy and disagreeable: but there was never danger of that in RAPHAEL.

The naked Boys, in the cartoon of Healing the Cripple, are a farther proof of RAPHAEL's great judgment in composition: one of them is in such an attitude as finely varies the turns of the figures; but here is moreover another kind of contrast, and that is caused by their being naked, which how odd soever it may seem at first, and without considering the reason of it, will be found to have a marvellous effect. Cloath them in imagination; dress them as you will, the picture suffers by it, and would have suffered, if RAPHAEL himself had done it.

It is for the sake of this contrast, which is of so great consequence in painting, that this knowing man, in the Cartoon we are now upon, has placed his figures at one end of the Temple, near the corner, where one would not suppose the beautiful gate was; but this varies the sides of the picture, and at the same time gives him an opportunity to enlarge his buildings with a fine Portico, the like of which you must imagine must be on the other side of the main structure; all which together, makes one of the noblest pieces of Architecture that can be conceived: nor is the contrast mentioned only necessary in every picture, but if several are made to hang in one room, they ought to contrast one another. The masters to be studied for Composition are RAPHAEL, RUBENS, REMBRANDT, and many others: there are worthy of notice.

Rules for drawing Beasts.

For drawing the form of any beast, begin with your Lead or Coal, at the Forehead, drawing downward the Nose, Mouth, upper and nether Chop, ending your lines at the Throat; then viewing it a-

gain where you began, from the Forehead over the Head, Ears, and Neck, continuing till you have given the full compass of the Buttock, then mark out the Legs and Feet. Viewing it again, touch out the Breast, with the eminency thereof; lastly, finish the Tail, Paws, Tongue, Teeth, Beard, and shadows. In drawing beasts, you must be well acquainted with their shape and action; without which you will never perform any thing excellent in that kind: and here if you draw it in an emblem or the like, you ought to shew the landscape of the country natural to that beast.

The Method of Colouring Beasts.

1. Sheep, lay with a thin *White*, shaded with *Indigo* and *Soot*, and heightened with *White*.

2. Hogs, lay with *Brown Oker*, shade with *Soot*, and heightened with *Masticote*: you may, as you see occasion, colour the Hair here and there with stronger *Brown Oker*; the Eyes with *Vermilion*, which you may heighten with *Masticote*; the Mouth with *Indigo*, or *White* and *Black*, shaded with *Black*.

3. A Bear, with brown *Oker*, red *Oker* and *Black* mixed; shadow with *Soot* alone, or mixed with *Black*, and heighten with brown *Oker* and *White*.

4. A Wolf, with brown *Oker* and *Soot*, and shadow with more *Soot*.

5. A Grey Wolf, with *Black*, *White*, and brown *Oker*; shaded with *Black* and *Soot*, or *Black* only; the Mouth with *Black* and red *Oker*; shaded with *Black* and *Soot*, heightened with red *Oker* and *White*.

6. The Elephant, which is of a Mouse Grey, with *Black* and *White*, mixed with *Soot*, and shaded with *Black* and *Soot*, and heightened with the same with a little more *White*. The Nose, at the end of his Trunk, inwardly must be laid with *Vermilion* and

Deer, shadowed with *Black*, or *Black* mixed with *Lake*: in the same manner, the inner part of the Ears; the Eyes with *White*, tending to a *Grey*. Mice are coloured as the Elephant: Rats a little browner.

7. The Unicorn, with a pure *White*, shaded with *Black*; the Chaps red, the Eye and Hoofs with a thin *Black*.

8. The Hart with brown *Oker*, shaded on the Back with *Soot*, which sweetly drive towards the Belly, and shade over again with a stronger *Soot*: the Neck and Belly with *White*, the Mouth and Ears a little reddish, the Hoof black, the Horns with *Soot*, and shaded with *Soot* mixed with *Black*. The Hind with the same colours as the Hart.

9. The Coney, with *Black* and *White*; the Belly all *White*, sweetened with *Black*, and heightened with a stronger *White*. The Hare with brown *Oker*; the Belly a little whitish; shaded on the Back with *Soot*, and heightened down the Belly with *White*.

10. Apes, Monkeys, and the like, with *Pink* and *Black*, heightened with *Masticote* and *White*; lay the Face with a thin *Black*, mixed with *Soot*, shaded with *Black* and *Pink* mixed with a little red *Oker*.

11. Cats, of grey and brownish, or *Tabby*, with *Indigo*, *Blue* and *White*, heightened with pure *White*, and shaded with *Indian Blue* and *Black* mixed.

12. An Afs, colour with *Black*, mixed with *White* like *Grey*; if the Afs be of a mingled brown, *Black* and *White* mixed with brown *Oker*, shaded with *Black* in the Mouth; heighten with *White*.

13. The Leopard, with brown and red *Oker* mixed with *Black*, shadow it with *Soot*; the Spots with red *Oker* and *Black*, the Mouth with *Black* and *White*, heighten with light *Oker*.

14. Horses, Oxen, Cows, Dogs, and such like, if white, with *White*, mixed with a little *Soot* or *Oker*, shaded with a little *Black* and *White*, and heightened with perfect *White*. If of a Chestnut brown, with

red *Oker* and *Black*, shaded with *Black* and *Soot*, and heightened with red *Oker* and *White*. If an *Ash grey*, with *Black* mixed with *White*, shaded with *Black* and heightened with *White*. If black, with a thin *Black*, shade with a stronger *Black*, and heighten with *Black* and *White*. — A bay Horse, with *Vermilion* and brown *Oker*; or only with red *Chalk*, shaded with red *Oker*, and heightened with red *Chalk*, mixed with *White*. If spotted, by a mixture of the aforesaid colours, and discreetly putting every one in its proper place.

CHAP. XV.

L I M N I N G.

LIMNING is the art of painting in Water. Colours, in contradiction to Painting, properly so called, which is done in Oil Colours. In Limning, all colours are proper enough, excepting the *White* made of *Lime*, which is only used in *Fresco*; but the *Azure* and *Ultramarine* must always be mixed up with *Size* or with *Gum*; because the *Yolks* of *Eggs* give *Yellow* colours a greenish tincture. The colours are all ground in *Water*, each by itself; and in proportion as they are wanted in working, are diluted with sized *Water*. The great advantage of limning consists in its being free from any lustre, in regard that all its colours, thus void of lustre, may be seen in all kinds of lights, which in *Oil*, or covered with *Varnish*, cannot.

Directions for using the Colours.

Your Pencils must be fast in their quills, and sharp-pointed after you have drawn them through your mouth. Before you begin, have all your colours ready before you, and a Pallet for the convenience of mixing them; a paper to lay under your hand, and to keep your work clean; as well as to try your colours upon; also a large brush called a Fitch, to wipe off the the dust when your colours are dry.

Lay your colours on but thinly at first, deepening and mellowing them by degrees as you see occasion. The quicker you lay them on, the evener and cleaner your Drawing will appear: take care to preserve all your colours from dust; and before you use them, wipe your shells and pallet every time with a fitch: when you have done your work, or would lay it aside, be careful to wash out your pencils in warm water.

For Face painting, mix up a little light *Carnation* or *Flesh* colour with Gum-water in a shell by itself if it be for a fair complexion, mix a little *Vermilion* and *White Flake* together; and for a swarthy one, add to the former a little *Masticote* or *English Oker*, or both. Let your *Flesh-colour* be always lighter than the complexion you would paint, for by working on it, you may bring it to its true colour. In a large shell, or upon your Pallet, lay your different shades of *Flesh-colour* at a convenient distance from each other; and always have ready a sufficient quantity of *White*, to lighten your shadows.

For the Cheeks, and Lips use a mixture of *Lake* and red *Lead* or *Germine*, as occasion requires; and for blue Tints (as under the Eyes, and in Veins) *Indigo* or *Ultramarine* and *White*: for grey and shadows, use *White*, *English Oker*; sometimes *Masticote*: for deep shadows, *White*, *English Oker*, *Umber*: for

darker shadows, *Lake* and *Pink*, which makes a good *flesh* shadow.

Let the person you are to limn be posited in the posture that he himself shall chuse, level with you, and not more than six yards from you at most. Observe the person's motion, if ever so small; for the least motion amiss, if not recalled, will insensibly lead you into many errors. For your further instructions in Face-painting we refer you to the subject on Drawing.

In colouring Landscapes, at first only lay dead colours smooth all over the piece, leaving no part uncovered; and be not over curious in this part of the performance, but rather use a masterly freedom; and the work, though seemingly rough to the eye, will have a good effect when placed at a distance. Let not the roughness of the colour discourage you, for it is easily to be softened by degrees with the other shadow, observing only to sweeten and heighten them according as the light falls. In some places lay on strong touches, and in those places bring your work up together to an equal roundness and strength, tempering and sweetening your colours with a sharper pencil than the first, that no lumps or harsh edges be left; but that all your shadows may lie dispersed, soft and smooth, gliding gently, as it were into one another.

You are not to finish any part before the other, but work up all the parts gradually alike till you see nothing wanting to compleat your picture. Having laid your dead colours, begin with the lightest parts, as the Sky, Sun beams, &c. then the yellowish beams (which are to be done with *Masticote* and *White*;) next the blueness of the Sky, with *Ultramarine* or *Smalt* alone: for purple Clouds only mix *Lake* and *White*, making your colours deeper as they go upwards from the horizon, except in tempestuous skies. The tops of distant Mountains must be

worked so faint, that they may seem to lose themselves in the air.

Bring your colours forward as your distance decreases; painting your first ground next the horizon downwards of a bluish *Sea-green*, and as you advance forwards of a reddish or darker *Green*, till you come to the foreground itself, which, as it is to be the darkest part of all, do with dark *Green*, shaded with a dark *Brown* or *Yellow*; which rule of shadow will also serve for the Trees on each respective ground. All distant objects are to be made imperfect as they appear to the eye, as has been already observed under the article of Light and Shade.

In colouring Trees, Boughs, and Branches, touch in all the dark shades first, raising the lighter leaves above the darker by adding *Masticote* to the dark *Green*, which may be made with *Bice*, *Pink*, and *Indico*, for the uppermost of all, which are to be done last; touch lightly the extremities of the leaves with a little *Green*, *Musticote*, and *White*, and set off the darkest shadows with *Sap-green* and *Indico*. These rules are adapted to general appearances; but the learner may deviate from them as Nature shall dictate.

With regard to Drapery, Fruits, Flowers, and other branches of Painting, the best observations are to be taken from the object themselves, or the most curious and exact representations of them. Lastly we would rather recommend to those who chuse to paint in Water Colours (chiefly for amusement) to buy their Pencils and Colours prepared at the Colour-shops; and such as will prepare them themselves, we refer to Colours in particular.

*A Method of Fresco Painting, or rather
Plastering on Walls, to endure the Wea-
ther, and representing Birds, Beasts,
Herbs, Fruits, &c. in Relief.*

It is performed on fresh Plaster, or on a wall laid with Mortar not yet dry, and with Water Colours: the method of painting in Fresco is as follows:

The plaster must be made of well washed Lime mixed with fine powder of old rubbish Stones; the Lime must be so often washed, till all its salt is extracted, and all the work must be done in clear dry weather; or it may be mixed well with Flints thoroughly burnt. And, in order to render the plaster more durable, they strike, into the joints of the brick or stone-wall, stumps of horse-nails at about six inches distance from each other, to prevent the plaster from peeling off. With this plaster the wall is first to be plastered, a good thickness, and left some time to dry; the design and colours being first ready prepared.

This painting is chiefly performed on walls and vaults, newly plastered with lime and sand; but plaster must only be laid in proportion as the painting goes on, no more being to be done at once than the painter can dispatch in a day, while it is moist. Before the painting is begun, there is usually a cartoon or design made of paper, to be chalked and transferr'd to the wall, about a quarter of an hour after the plaster has been laid on. The colour being prepared and mingled, the wall is to be plastered over again the second time, about the thickness of half a crown; but only so much as you intend presently to work upon, and while it is wet, you must work the colours therein, which will mix and incorporate with the plaster, so as never to wash out.

The painting must be, for the work to come in all its beauty, wrought quick, and with a free hand; for there can be no mending or alteration after the first painting, and therefore make your colour high enough at first; yet you may deepen but not easily lighten: nor must they ever be retouched dry, with colours mixed up with the white of an Egg, Size, or Gum, as some workmen do, by reason that such colours grow blackish; nor do any preserve themselves but such as were laid on hastily at first. In this painting all the compound and artificial colours and almost all the minerals are set aside, and scarce any thing used but earth's; which are capable of preserving their colour, defending it from the burning of the lime, and resisting its salts.

The colours used are *White*, made of *Lime* flacked long ago, and white *Marble* dust, *Oker*, both red and yellow, *Violet*, red *Verditer*, *Lapis Lazuli*, *Black*, *Spanish brown*, *Spanish white*, &c. all which are only ground, and worked up with *Lime-water*, *Milk*, or *Whey*; and most of them grow brighter and brighter as the *Fresco* dries.

The brushes and pencils for this work must be long and soft, or else they will rake and raise the painting. The colours must be full and flowing from the brush; the design perfect in the image or paper copy, for in this work you cannot alter or add upon any colour.

This sort of painting has a great advantage, by its incorporating with the mortar, and drying along with it; it is rendered extremely durable, and never fails nor falls, but along with it. Before the painter begins his work he must prepare all the chief tints, and put them into separate pots; then try the colours on a dry smooth tile, for the tile presently imbibing all that is moist in them, and drying them, they see by it, what effect they will have when used.

CHAP. XVI.

GILDING.

GILDING is the art of spreading or covering any thing over with Gold, either in Leaf or Liquid. There are several methods of gilding in use amongst us, as Gilding in Water, Gilding in Oil, Gilding by Fire, &c.

The Method of Water Gilding.

Water Gilding requires more preparation than Oil Gilding, and is chiefly on wooden works, and those made of *Stucco*, and these too must be sheltered from the weather. A *size* is used for this way of gilding, made of threads, &c. of Parchment, or Gloves, boiled in water, to the consistence of a jelly. If the thing to be gilt be of wood, it is first washed with this size, boiling hot, and then set to dry; and afterwards with *white* paint, mixed up with the same size: some use *Spanish white* for this purpose, and others *Plaster of Paris*, well beaten and sifted: this size paint must be laid on with a stiff brush; which is to be repeated seldom or oftener, according to the nature of the work, as ten or twelve times in flat or smooth works; but seven or eight will be sufficient in pieces of Sculpture: in the former case they are applied by drawing the brush over the work, in the latter by dabbing it.

When the whole is dry, they moisten it with fair water, and rub it over with several pieces of coarse linen, if it be on the flat; if not, they beat or

switch it with several slips of the same linen tied to a little stick, to make it follow and enter all the cavities and depressures thereof. Having thus finished the *White*, the next thing to be done is to colour it with yellow *Oker*; but if it be a piece of Sculpture in Relievo, they first touch it up, and prepare the several parts which may have happened to have been disfigured by the small iron instruments, as gouges, chissels, &c. the *Oker* used for this purpose must be well ground and sifted, and mixed up with the size before mentioned. This colour is to be laid on hot; and in works of Sculpture, supplies the place of Gold; which, sometimes, cannot be carried into all the depressures and cavities of the Foliages and other ornaments. A lay is also applied over this Yellow, which serves for the Ground on which the Gold is to be laid; this lay is usually composed of *Armenian bole*, *Bloodstone*, *black Lead*, and a little fat; to which some add *Soap* and oil of *Olives*; others burnt Bread, *Bistre*, *Antimony*, *Glass of Tin*, *Butter*, and *Sugar-candy*.

These ingredients being all ground together with hot size, three lays of this composition are applied upon the yellow, the one after the other has been dried; being cautious not to put any into the cavity of the work to hide the yellow. The brush used for this purpose must be a very soft one, and, when the matter is become very dry, they go over it again with a stronger brush to rub it down, and take off the small grains that stick out, in order to facilitate the burnishing of the Gold.

To be prepared for gilding, you must have three sorts of pencils; one to wet, another to touch up and amend, and a third to flatten; also a Gilding Cushion for spreading the leaves of Gold on, when taken out of the book; a Knife to cut them and a Squirrel's tail fitted with a handle; or else a piece of fine soft stuff on a stick, to take them up and ap-

ply them. You are first to begin with wetting your pencils; by which the last Lay laid on with water is moistened, the better to receive and retain the Gold. Then you are to lay the leaves of Gold on the Cushion, and if whole, you must take up with the Squirrel's tail; but, if in pieces, with the other instrument, or Knife wherewith they are cut, and lay and spread them gently on the parts of the work you had moistened before. If the leaves, as they frequently do, happen to crack or break in laying on, these breaches must be made up with small bits of leaves taken upon the repairing pencil, and the whole work is to be smoothed either with the same pencil, or another something larger; the Gold being pressed into the dents, into which it could not be so easily carried by the Squirrel's tail.

The work having been thus far gilded, must be set to dry, in order to be either burnished or flatted. Burnishing is smoothing and polishing it with a burnishing tool, which is usually a Dog or Wolf's tooth, or a bloodstone fitted into a handle for that purpose.

Flatting it is giving it a light lick, in the places not burnished, with a pencil dipped in Size, in which a little *Vermilion* sometimes has been mixed: this serves to preserve and prevent its flawing when handled. The last operation is applying the *Vermeil* in all the little lines and cavities, and to stop and amend any little faults with shell Gold. The composition called *Vermil* is made of Gum *Guttac*, *Vermilion*, and a little of some ruddy brown colour, ground together, with *Venetian* Varnish and Oil of *Turpentine*. Some Gilders instead of this, make shift with fine *Lucca* or *Dragon's* Blood with Gum-water. Sometimes instead of burnishing the Gold, they burnish the Ground or composition laid on the last before it, and only afterwards wash the part over with the Size. This method is chiefly practised for the Hands, Face, and other nudities in *Relievo*; which by this means, do not appear so very brilliant as the parts burnished,

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though much more so than the parts perfectly flat. To gild a piece of work, and yet preserve white grounds, they apply a lay of Spanish *White* mixed with a weak fish glue on all the parts of the ground; whereon the yellow or the last lay might run.

The Method of gilding in Oil.

This operation requires much less apparatus than that before mentioned. The basis or matter whereon the Gold is laid, in this method, is the remains of colours found settled to the bottom of the pots in which painters wash their pencils. This matter which is very vici'd or sticky, is first ground, and then passed through a linen cloth; and thus laid with a pencil on the matter to be gilded, after it has been washed once or twice over with *Size*; and if it be wood, with some *white* paint: when this is almost dry, but yet is still unctuous enough to catch and retain the Gold, the leaf Gold is laid on; either whole, if the work be large, or cut to pieces if smaller; the leaves of Gold are taken up and laid on with a piece of fine, soft, well carded cotton; or sometimes by a pallet for the purpose, or sometimes with the knife with which the leaves were cut, according to the parts of the work that are to be gilded, or the breadth of the Gold that is to be laid on. As the Gold is laid on, they pass over it a coarse stiff pencil or brush to make it stick, and as it were, incorporate with the ground: and after this, they mend any cracks that may have happened in it, either with the same pencil or one that is smaller; as has been shewn before in *Water Gilding*. This kind of Gilding is chiefly used for domes and roofs of Churches, Courts, Banquet-houses, &c. and for figures of Plaster of Paris, Lead, &c.

The Method of gilding with Liquid Gold.

This is performed by Gold reduced to a Calx and amalgamated with *Mercury*, in the proportion of about an ounce of *Mercury* to a drachm of Gold. To perform this, they heat a crucible red hot, and then put the Gold and *Mercury* into it, stirring them gently about till the Gold be found melted, and incorporated into a mass with the *Mercury*. When this is done, they cast them into water to wash and purify them; and out of that into other waters, where the Amalgama which is almost as liquid, as if there were nothing but Quicksilver in it, may be preserved a long time for use. Before they proceed to lay this amalgamated gold on the metal, they first render the metal rough, by washing it over with *Aqua fortis* or *Aqua-jecunda*; and afterwards rinse the metal in fair water, and scour it a little with fine Sand, and then it is ready for the Gold: then they cover over the metal with the mixture of Gold and *Mercury*, taking it up with a slip of Copper, or brush made of Brass wire, spreading it as even as possible, to do which they wet the brush from time to time in fair water; then they set the metal to the fire upon a grate in a sort of cage, under which stands a pan of coals; and in proportion as the *Mercury* evaporating and flying off discovers the places where the Gold is wanting, they take care to supply them by adding new parcels of Amalgama. Then the work is rubbed over with the wire brush dipped in Beer or Vinegar, which leaves it in a condition to be brought to a colour, which is the last part of the process; and which the Gilders keep to themselves as a mighty secret; though it is certain it cannot differ much from the manner of giving Gold species their colour in coining.

To gild GLASS.

Take *Chalk* and red *Lead*, of each a like quantity grind them together and temper with *Linseed* oil; lay it on, and, when it is almost dry, lay leaf *Gold* on; let it dry, and then polish it.

To gild IRON.

Take one pound of liquid *Varnish*, *Linseed* oil, and *Turpentine*, of each one ounce; mix them well together, strike them over any metal, and afterwards lay on leaf *Gold* or *Silver*, and when it is dry polish it.

To gild *Silver*, *Brass*, or *Copper*, with *Gold-water*.

Take two ounces of *Quicksilver*, put it into a crucible, set it on the fire, and when it begins to smok, put in an Angel of fine *Gold*; then take it off immediately, for the *Gold* will be presently dissolved; then, if it be too thin, strain a part of the *Quicksilver* from it through a piece of *Fustian*; when you have done this, rub the *Gold* and *Quicksilver* upon *Brass* or *Silver*, and it will cleave to it; then put the said *Brass* or *Silver* upon quick coals, till it begins to smok; then take it from the fire, and scratch it with a hair brush; this do till all the *Mercury* is rubbed as clean off as may be, and the *Gold* appears of a faint yellow: then heighten the colour with *Sal Armoniac*, *Bole*, and *Verdigrease*, ground together and tempered with water.

You must take notice that, before you gild upon metal, you must boil it in *Tartar*- or *Beer* and *Water*.

To gild on WOOD or STONE.

Take *Bole Armoniac* and *Oil of Ben*, of each a sufficient quantity: beat and grind them together,

and smear the Wood or Stone, and, when it is almost dry, lay on leaf Gold, let it dry, and polish it.

To silver any Metal.

Dissolve fine Silver in strong *Aqua fortis*, and put in as much *Tartar* finely powdered as will make it into a paste: with which rub any metal, and it will look like fine Silver.

CHAP. XVII.

Of ETCHING.

ETCHING is a method of working on Copper wherein the lines or strokes, instead of being cut with a Graver, are eaten with *Aqua Fortis*.

This art, being executed with greater ease and freedom than Engraving, represents curious subjects better, and more agreeable to Nature, as Landscips, Ruins, and small, faint, or remote Objects, Buildings, &c.

The principal Materials for this art are the Plate, hard and soft Ground, (the first for Winter, and the other for Summer,) a Dabber, Turpentine Varnish, Lamp-Black, soft Wax, and Aqua Fortis.

The Tools are, an Oil-Rubber, a Burnisher, a Scraper, a Hand-Vise, Etching-Boards, Etching-Needles, an Oil-Stone, and a Parallel Ruler.

Directions for laying the Ground.

Having provided yourself with a plate of the size of the print or drawing you intend to copy, rub it well with an oil-rubber made of swan-skin flannel, till all the marks of the charcoal used in polishing it, entirely disappear; then, wiping off the dirty oil with a linnen rag, dip your finger in some clean oil, and touch it over every part of the plate; after which with your burnisher polish the plate, till you can see your face in it: And in case any sand-holes or flaws appear, the scraper will assist you in taking them out. The marks left by the scraper are to be taken out with the burnisher, till nothing appear. Having fixed your hand-vice at one end of the plate, with a rag and whiting clear the plate carefully from grease; then heat it over a charcoal fire, or lighted paper, till it will melt the ground, which is to be laid on thinly, and dabbed all over with the dabber, till it is perfectly smooth and even; then warm the plate again, and holding it up with the ground downwards, smooke it all over with a large candle, taking care that the snuff do not touch the ground, and waving the candle continually over every part, so that the ground may not be burnt by heating it more in one place than another. If the plate be large you may join four penny candles together.

Directions for Tracing.

The first thing to be done, (while the plate is cooling, after the ground is laid) is to rub the back of your print or drawing all over with a bit of clean rag or cotton, dip in the scrapings of red chalk, and

shake off the loose dust, or wipe it off gently with a clean rag. Place the red side upon the plate, making it fast at each corner with a bit of soft wax.—Lay your etching-board under your hand, to prevent bruising the ground; then with a blunt etching needle trace lightly the out-lines and breadths of the shadows, till the marks of them appear upon the ground, which you must take care not to penetrate by tracing too hard.

As great nicety is required in this part of your work, it will be necessary now and then to lift up one part of your original, and examine whether every part be traced before you take it off, as it will be extremely difficult to lay it down again in its former position.

Directions for Etching.

Having carefully traced your original, take it off, and lay a silk or linen handkerchief next the plate, and over that your etching-board; then proceed to the etching: for which observe the following directions, which are adapted to every particular branch, as landskips, shipping, portraits, history, architecture, &c.

Distances in Landskips, or the faint parts of any other picture, are the first to be done; and these are to be worked closer, and with a sharper pointed needle: The darker parts must be etched wider, and with a blunter needle; but to prevent mistakes, the needles may be marked, according to their different degrees, and the uses for which they are intended. As for the very faintest parts of all, they are to be left for the graver, or dry needle; of which hereafter.

In building, and all architecture in general, use a parallel

parallel ruler, till frequent practice enables you to do them well enough without.

The needles when necessary, must be whetted upon your oil-stone, keeping them turning in your hand, so as to whet them equally all round. The oil-stone will be farther useful in whetting the scraper, which is to be rubbed flat upon the stone, and with a steady hand, keeping oil constantly upon the stone.

Of biting or eating in the Work with Aqua Fortis.

First examine your work carefully, to see that nothing be omitted; and if any scratches appear upon the ground, or mistakes be committed in the etching, they are to be stopped out, which is done by covering them with a mixture of lamp-black and varnish, laid on thinly with a hair pencil, which, when dry, will resist the Aqua Fortis. But it will be best to stop out these, as they occur to you in the course of your work, for by this means they will be less liable to escape your notice; and when the varnish is dry, you may etch over it again, if required.

The next thing is, to enclose the work with a rim or border of soft green, or other coloured wax, about half an inch high, bending the wax in the form of a spout at one corner, to pour off the Aqua Fortis: And that it may not run out at any other part, take care to lay your wax so close to the plate, that no vacancies be left.

Your Aqua Fortis must be single, and if too strong, which will be seen in the biting, take it off, and mix it with a little water, shaking them together in a bottle; and when, by often using, it becomes too weak, it may be strengthened by mixing it in a bottle with a little double Aqua Fortis. The bottle

which contains the Aqua Fortis should have a large mouth, and a glass stopple.

Let the Aqua Fortis lie on the plate a short time, wiping off the bubbles, as they arise, with a feather, which may remain upon the plate while it is biting; after which take it off, and wash the plate with water; then let it dry; and, by scraping off part of the ground, from the faintest part of the work, try if it be bit enough; and if not, stop out the part you have tried with the lamp-black and varnish; and when that part is dry, pour on the Aqua Fortis again.

When the faint parts of your work are bit enough, stop them out, and proceed to bite the stronger parts, stopping them out as occasion requires, till the whole work is sufficiently bit: Then warm the plate, and take off the soft wax; after which, heat the plate till the ground melts, pour on a little oil, and wipe the whole off with a rag. When the ground is taken off, rub the whole work well with the oil-rubber, and wipe the plate clean; then proceed to finish it with the graver, according to the following directions.

A great pains are required to make the graver, which is usually the belly of a cat, may be kept to lay the two halves of the graver, which are to be held next the plate, that it may not slip, and rub them lightly till they are polished like a mirror, and till the belly has a small space above the plate to as that when you lay the graver on upon it, you may just perceive the light under the point; otherwise it will be impossible to keep a point, or execute the work with freedom. In order to this, keep your right arm close to your side, and have the fore finger of your left hand up

CHAPTER XVIII.

OF ENGRAVING.

THE tools necessary for engraving are, the Oil-rubber, Burnisher, Scraper, Oil-stone, Needles, and ruler, already mentioned to be used in etching, also, gravers, compasses, and a sand bag,

Gravers are of two sorts, square and lozenge; three of each sort should be provided. The first is used in cutting the broader strokes, the other for the fainter and more delicate. No graver should exceed the length of five inches and a half; the handle included, excepting for strait lines.

The sand-bag or cushion, is used to lay the plate on, for the conveniency of turning it about. The Oil-stone must be of the Turkey sort.

Of holding the Graver.

As great pains are required to whet the graver nicely, particularly the belly of it, care must be taken to lay the two angles of the graver, which are to be held next the plate, flat upon the stone, and rub them steadily till they are polished like a mirror, and till the belly rises *gradually* above the plate, so as that when you lay the graver flat upon it, you may just perceive the light under the point; otherwise it will dig into the copper, and it will be impossible to keep a point, or execute the work with freedom. In order to this, keep your right arm close to your side, and place the fore finger of your left hand up-

on that part of the graver which lies uppermost on the stone. When this is done, in order to whet the face, place the flat part of the handle in the hollow of your hand, with the belly of the graver upwards, upon a moderate slope, and rub the extremity or face upon the stone, till it has an exceeding sharp point, which you may try upon your thumb nail. The oil-stone, while in use, must never be kept without oil.

When the graver is too hard, as is usually the case when first bought, and may be known by the frequent breaking of the point, the method of tempering the steel is as follows :

Heat a poker red hot, and hold the graver upon it within a little of the point, waying it to and fro till the steel changes to a light straw colour ; then put the point into oil to cool : or, hold the graver close to the flame of a candle, till it be of the same colour, and cool it in the tallow : But be careful either way not to hold it too long, for then it will be too soft ; and in this case the point, which will then turn blue, must be broken off, and whetted afresh, and be tempered again if required. But be not too hasty in tempering ; for sometimes a little tempering will bring it to a good condition.

Of holding the Graver.

Cut off that part of the handle which is upon the same line with the belly, or sharp edge of the graver, making that side flat, that it may be no obstruction.

Hold the handle in the hollow of your hand ; and extending your fore-finger towards the point, let it rest upon the back of your graver, that you may guide it flat, and parallel with the plate.

Take

Take care that your fingers do not interpose between the plate and the graver, for they will prevent you from carrying the graver level with the plate, and from cutting your strokes so clean as they ought to be.

Directions for Engraving.

Let the table or board you work at be firm and steady; upon which place your sand bag with the plate upon it; and holding the graver as above directed, proceed to business in the following manner:

For strait strokes, hold your plate firm upon the sand-bag with your left hand, moving your right hand forwards; leaning lighter where the stroke should be fine, and harder where you should have it broader.

For circular or crooked strokes, hold the graver stedfast, moving your hand or the plate, as you see convenient.

Learn to carry your hand with such a slight, that you may end your stroke as finely as you began it; and if you have occasion to make one part deeper or blacker than another, do it by degrees: And that you may do it with greater exactness, take care that your strokes be not too close, nor too wide.

In the course of your work, scrape off the barb or roughness which arises, with the belly of your graver; but be careful in doing this, not to scratch the plate: And that you may see your work properly as you go on, rub it with the oil-rubber, and wipe the plate clean, which will take off the glare of the copper, and shew what you have done to the best advantage.

Any mistakes or scratches in the plate may be rubbed out with the burnisher, and the part levelled with

the scraper, polishing it again afterwards lightly with the burnisher.

Having thus attained the use of the graver according to the foregoing rules, you will be able to finish the piece you had etched, by graving up the several parts to the colour of the original; beginning, as in Etching, in the faintest parts, and advancing gradually with the stronger, till the whole is completed.

The dry needle (so called because not used till the ground is taken off the plate) is principally employed in the extreme light parts of water, sky, drapery, architecture, &c.

For your first practice, copy such prints as are openly shaded; the more finished ones being too difficult, till you have gained farther experience.

To prevent any obstruction from too great a degree of light, we would recommend the use of a sash, made of transparent fan-paper, pasted on a frame, and placed sloping at a convenient distance between your work and the light. This will not only preserve the light, but, when the sun shines, cannot possibly be dispensed with.

CHAP. XIX.

Of MEZZOTINTO-SCRAPING.

THIS art, which is of late date, is recommended to the practice of the ingenious Reader, for the amazing ease with which it is executed, especially by those who have any notion of drawing.

Mezzotinto Prints are those which have no Hatching or Strokes of the Graver, but whose Lights and Shades are blended together, and appear like a Drawing of Indian Ink.

The Tools used in this Art are, The Copper-Plate, Oil-Stone, Grounding-Tools, Scrapers, Burnisher, and Needles,

Directions for laying the Mezzotinto-Ground.

Mark off upon the Bottom of the Plate the distance you intend to leave for the writing, coat of arms, &c. then, laying your plate with a piece of Swan-skin-flannel under it, upon your table, hold the grounding tool in your hand perpendicularly, lean upon it moderately hard, continually rocking your hand in a right line from end to end, till you have wholly covered the plate in one direction: Next cross the strokes from side to side, afterwards from corner to corner, working the tool each time all over the plate, in every direction, almost like the points of a compass, taking all possible care not to let the tool cut (in one direction) twice in a place. This done, the plate will be full, or, in other words, all over rough

rough alike, and would, if it were printed, appear completely black.

Having laid the ground, take the scrapings of black chalk, and with a piece of rag rub it over the plate; or you may, with two or three candles, smoak it, as before directed for Etching.

Now, take your Print or Drawing, and having rubbed the Back with red Chalk Dust, mixed with White Lake, proceed to trace it as directed.

Directions for whetting the Grounding-Tool.

If a Tooth of the Tool should break, it may be perceived in the Working by a particular Streak or Gap, which will appear in the Ground in a strait Line; in which case the Tool must be whetted on the Back, holding it sloping, and in a circular Manner, like the Bottom of the Tool.

Directions for scraping the Picture.

Take a blunt needle, and mark the outlines only, then with a scraper scrape off the lights in every part of the plate, as clean and smooth as possible, in proportion to the strength of the lights in your picture, taking care not to hurt your outlines: and that you may the better see what you do, with the thumb and fore-finger of the left hand hold a piece of transparent paper, sloping, just over your right hand; and you will soon be a judge of the different tints of the work you are doing; scraping off more or less of the ground, as the different strengths of lights and tints require.

The use of the Burnisher is, to soften or rub down the extreme light parts after the scraper is done with, such as the tip of the nose, forehead, linen, &c. which might otherwise, when proved, appear rather misty than clear.

Another method used by Mezzotinto-Scrapers, is to etch the outlines of the original, as also of the folds in drapery, marking the breadth of the shadows by dots which having a bit of a proper colour with aqua fortis according to the directions given and take of the ground used in etching, and having laid the mezzotinto-ground proceed to scrape the picture as before directed.

Four or five days before you think the plate will be ready for proving, notice must be given to the rolling-press printer, to wet some French paper, as no other will do for this work, and as that time is necessary for it to lie in wet. When the proof is dry, touch it with white chalk where it should be lighter, and with Black chalk where it should be darker; and when the print is retouched, proceed as before for the lights, and for the shades use a small grounding-tool, as much as you judge necessary to bring it to the proper colour; and when you have done as much as you think expedient, prove it again, and so proceed to prove, and touch, till it is entirely to your mind. when the plate tarnishes in the part where you are at work, a little vinegar and salt kept by you in a vial will take it off, whiping it dry with a clean rag.

Avoid as much as possible over-scraping any part before the first proving, as by this caution the work will appear the more elegant.

CHAP. XX.

PAINTING upon GLASS.

PAINTING upon GLASS is an art which has generally appeared difficult; yet there is no representation can be more elegant than that of a picture done well in this manner: for it gives all the softness that can be desired in a picture, and is easy to work; as there are no outlines to draw, nor any Shade to make, but the the colours are put on without the trouble of either.

The pictures are those done in Mezzotinto; for their shades being rubbed down on the glass, the several lines which represent the shady part of any common print, are by this means blended together, and appears as soft and united as in any drawing of *Indian Ink*.

Provide such mezzotintos as you like; cut off the margin; then get a piece of fine crown glass, the size of your print, (as flat and free from knots or scratches as possible,) clean the glass, and lay some *Venice Turpentine*, quite thin and smooth, on one side thereof, with a brush of hog's Hair, lay the print flat in water, and let it remain on the surface till it sinks; 'tis then enough: take it carefully out, and dab it between some papers, that no water may be seen, yet so as to be damp.

Next, lay the damp print, with its face uppermost, upon a flat table; then, holding the glass over it, without touching the turpentine till it is exactly even with the print, let it fall gently on it. Press the glass down carefully with your finger in several

parts, so that the turpentine may stick to the print; after which, take it up; then, holding the glass towards you, press the print with your fingers, from the center towards the edges, till there be no blisters remaining.

When this is done, wet the back of your print with a sponge, till the paper will rub off with your fingers; then rub it gently, and the white paper will roll off, leaving the impression only upon the glass: then let it dry, and with a camel's Hair pencil, dipt in oil of turpentine, wet it all over, and it will be perfectly transparent, and fit for painting.

Colours proper for painting upon Glass.

Whites.

Reds.

Flake White.

Rose Pink.

Spodium.

Vermillion.

Red Lead.

Blacks.

Indian Red.

Lamb Black.

Lake Cinnabar.

Ivory Black.

Yellows.

Browns.

English Pink.

Spanish Brown.

Masticot.

Umber.

English Oker.

Spruce Oker.

Saunders's Blue.

Dutch Pink.

Smalt.

Orpiment.

Greens.

Blues.

Verdigrease.

Blue Bice.

Terra Vert.

Prussian Blue.

Verditer.

The ultramarine (for Blue), and the carmine (for red), are rather to be bought in powders, as in that case they are less apt to dry, or be lost: And as the least touch of these will give the picture a cast, mix up what you want for present use with a drop or two of nut-oil upon your pallet, with your pallet-knife.

To get the colour out of the bladders, prick a hole at the bottom of each, and press it till you have enough upon your pallet for present use; because the colours are apt to dry and skin over.

Then lay a Sheet of white paper on the table, and taking the picture in your left hand, with the turpentine side next you, hold it sloping (the bottom resting on the white paper), and all the outlines and tints of the print will be seen on the glass; and nothing remains but to lay on the colours proper for the different parts as follows.

The Method of using the Colours.

As the lights and shades of your picture open, lay the lighter colours first on the lighter parts of your print, and the darker over the shaded parts; and having once laid on the brighter colours, it is not material if the darker sorts are laid a little over them; for the first colour will hide those laid on afterwards, as for example,

Reds.

Lay on first the red lead, and shade with lake or carmine.

Yellows.

The lightest Yellow laid on first, may be shaded with *Dutch Pink*.

Blues.

Blue Bice or Ultramarine, used for the lights, may be shaded with Indigo.

Greens.

Lay on Verdigrease first, and then a mixture of that and *Dutch Pink*. This Green may be lightened by an addition of *Dutch Pink*.

When any of these colours are too strong, they may be lightened to any degree, by mixing White with them upon your pallet: or you may darken them as much as you please, by mixing them with a deeper shade of the same colour.

The colours must not be laid on too thick; but if troublesome, thin them before you use them, with a little Turpentine-oil.

Take care to have a pencil for each colour; and never use that which you have used for Green with any other colour, without first washing it well with Turpentine-oil, as that colour is apt to appear predominant when the colours are dry.

Wash all the pencils after using in Turpentine-oil.

Your Glass, when painted, must stand three or four days free from dust, before it be framed.

CH A P. XXI.

Of B R O N Z I N G.

BRONZING is colouring by metalline powders, plaister, or other busts and figures, in order to make them appear as if cast of copper or other metals.

This is sometimes done by means of cement; and sometimes without, in the instance of plaister figures; but the Bronzing is more durable and secure when a cement is used.

Gold powders and *aurum Mosaicum* are frequently employed for this purpose; but the proper bronzing ought to be of a deeper and redder colour, more resembling copper; which effect may be produced by grinding a very small quantity of red lead with these powders; or the proper powder of copper may be used: and may be prepared as follows;

“ Take filings of copper, or slips of copper-plates;
“ and dissolve them in any kind of *aqua-fortis* put into
“ a glass receiver, or other proper formed vessel.—
“ When the *aqua-fortis* is saturated with the copper
“ take out the slips of the plates; or, if filings were
“ used, pour off the solution from what remains un-
“ dissolved: and put into it small bars of iron:
“ which will precipitate the copper from the *aqua-*
“ *fortis* in a powder of the proper appearance and
“ colour of copper. Pour off the water then from
“ the powder; and wash it clean from the salts, by
“ several successive quantities of fresh water.”

The *aurum Mosaicum*, which is tin-coloured, and rendered of a flaky or pulverine texture, by a chemical process, so as greatly to resemble gold powder, is prepared in the following manner.

“ Take of tin one pound, of flowers of sulphur
 “ seven ounces, and of *sal Ammoniacus* and purified
 “ quicksilver each half a pound. Melt the tin; and
 “ add the quicksilver to it in that state: and when
 “ the mixture is become cold, powder it, and grind
 “ it with the *sal Ammoniacus* and sulphur, till the
 “ whole be thoroughly commixt. Calcine them in
 “ a matraass; and the other ingredients subliming,
 “ the tin will be converted into the *aurum Mosaicum*:
 “ and will be found in the bottom of the glass like a
 “ mass of bright flaky gold powder: but if any
 “ black or discoloured parts appear on it, they
 “ must be carefully pickt or cut out.”

The method of making the silver powders, is also
 the same as those of gold, except with regard to one
 of the German powders, which is correspondent both
 in its appearance and use, abating the difference of
 colour, to the *aurum Mosaicum* or *musivum*: whence
 it has been indeed, though improperly called the *arg-
 gentum musivum*. The process for this being, there-
 fore, different from the above, it is proper to insert
 it fully, as follows.

“ Take of very pure tin one pound. Put it into
 “ a crucible, and set it on a fire to melt: when it be-
 “ gins to run into fusion, add to it an equal propor-
 “ tion of bismuth, or tin glass: and stir the mix-
 “ ture with an iron rod, or the small end of a to-
 “ bacco-pipe, till the whole be entirely melted,
 “ and incorporated. Take the crucible then from
 “ the fire; and, after the melted composition is
 “ become a little cooler, but while it is yet in a flu-
 “ id state, pour into it a pound of quicksilver gra-
 “ dually; stirring it in the mean time, that the
 “ mercury may be thoroughly conjoined with the
 “ other ingredients. When the whole is thus com-
 “ mixt, pour the mass out of the crucible on a stone,
 “ where, as it cools, it will make the form of an
 “ amalgama or metalline paste; which will be cali-

“ ly bruised into a flaky powder; and is then fit
“ for use.”

Where the appearance of brass is designed, the gold powders, or the *aurum Mosaicum*, may be mixt with a little of the powder called *argentum musivum*; of which the preparation is before given.

Where the appearance of silver is wanted, the *argentum musivum* is the best and cheapest method: particularly, as it will hold its colour much longer than the true silver used either in leaf or powder.

Where no cement is used in bronzing, the powder must be rubbed on the subject intended to be bronzed, by means of a piece of soft leather, or fine linen rag, till the whole surface be coloured.

The former method of using a cement in bronzing was, to mix the powders with strong gum-water or singlass size; and then with a brush, or pencil, to lay them on the subject. But at present some use the jappanners gold size; and proceed in all respects in the same manner as in gilding with the powders in other cases: the size is made as follows.

“ Take of linseed oil one pound, and of gum ani-
“ mi four ounces. Set the oil to boil in a proper
“ vessel; and then add the gum animi gradually in
“ powder; stirring each quantity about in the oil,
“ till it appear to be dissolved; and then putting in
“ another, till the whole be commixt with the oil.
“ Let the mixture continue to boil, till, on taking
“ a small quantity out, it appear of a thicker consist-
“ ence than tar; and then strain the whole through
“ a coarse cloth, and keep it for use. But when
“ is wanted; it must be ground with as much vermi-
“ lion, as will give it an opaque body; and at the
“ same time diluted with oil of turpentine, so as to
“ render it of a consistence proper for working
“ freely with the pencil.”

This is the best method hitherto practised. For the jappanners gold size binds the powders to the ground, without the least hazard of peeling or falling off; which is liable to happen when the gum-water

or glovers or isinglass sizes are used. Though, notwithstanding the old practice for the contrary, even these cements will much better secure them when they are laid on the ground, and the powders rubbed over them, than when both are mixed together, and the effect, particularly of the *aurum Mosaicum*, will be much better in this way than the other. The gold size should be suffered, in this case, to approach much nearer to dryness, than is proper in the case of gilding with leaf gold, as the powders would otherwise be rubbed amongst it in the laying on.

The fictitious silver powder, called the *argentum musivum*, may, as before-mentioned, be applied in the manner of bronze, by those whose caprices dispose them to silver figures or busts. But it is the only sort of silver powder, that should be used in this way, for the reasons before given: and all such kind of silvering is much better omitted. For the whiteness itself of plaster in figures or busts, and much more a glossy or shining whiteness, is injurious to their right effect; by its eluding the judgment of the eye, with respect to the proper form and proportion of the parts, from the false and pointed reflections of the lights, and the too faint force of the shades. To remove which inconvenience it is probable was the first inducement to bronzing.

Wood may also be stained yellow by means of
 which will sometimes produce a beauti-
 ful yellow colour, but at other times a browner
 The wood should be immediately after
 and on; and be held to the fire immediately after
 CHA. XXII.
**Of staining Wood, Ivory, Bone, Horn, Ala-
 baster, Marble, and other Stones of vari-
 ous Colours.**

In order to render any of these materials more beauti-
 ful and durable, the wood should be painted after it
 is coloured; when desired to be very strong, and to take
 Of staining Wood yellow.

TAKE any white wood; and brush it over se-
 veral times with the tincture of turmeric root,
 made by putting an ounce of the turmeric ground to
 powder to a pint of spirit; and, after they have
 stood some days, straining off the tincture. If the
 yellow colour be desired to have a redder cast, a li-
 tle dragon's blood must be added, in the proportion
 that will produce the teint required.

A cheaper, but less strong and bright yellow, may
 be given to wood, by rubbing it over several times
 with the tincture of French berries, prepared as fol-
 lows, and made boiling hot.

Take a pound of French berries, and put to
 them a gallon of water, with half an ounce of al-
 um: boil them an hour in a pewter vessel, and
 then filter off the fluid, (through paper if it be de-
 signed for nicer purposes, or flannel for more or-
 dinary.) Put them again into the boiler, and e-
 vaporate the fluid till the colour appear of the
 strength desired; or any part may be taken out
 while it is less strong, and the rest evaporated to a
 proper body.

After the wood is again dry, it should be brushed
 over with a weak allum-water used cold.

Smaller pieces of wood, instead of being brushed
 over with them, may be soaked in the decoctions or
 tinctures.

Wood may also be stained yellow by means of *aqua fortis*; which will sometimes produce a beautiful yellow colour, but at other times a browner. The wood should be warm, when the *aqua fortis* is laid on; and be held to the fire immediately afterwards; and care must be taken, that either the *aqua fortis* be not too strong; or that it be sparingly used; otherwise a brown, sometimes even a blackish colour, may be the result.

In order to render any of these stains more beautiful and durable, the wood should be brushed after it is coloured; and then varnished by seed-lac varnish, or, when desired to be very strong, and to take a high polish, with three or four coats of shell-lac varnish.

Of staining Wood red.

For a bright red stain for wood, make a strong infusion of Brasil in stale urine, or water impregnated with pearl-ashes, in the proportion of an ounce to a gallon; to a gallon of either of which, the proportion of Brasil wood must be a pound: which being put to them, they must stand together two or three days, often stirring the mixture. With this infusion strained, and made boiling hot, brush over the wood to be stained; till it appear strongly coloured; then, while yet wet, brush it over with alum-water made in the proportion of two ounces of alum to a quart of water.

For a less bright red, dissolve an ounce of dragon's blood in a pint of spirit of wine; and brush over the wood with the tincture, till the stain appear to be as strong as is desired. But this is, in fact, rather lacquering than staining.

For a pink or rose red, add to a gallon of the above infusion of Brasil wood two additional ounces of the pearl-ashes, and use it as was before directed.

but it is necessary, in this case, to brush the wood over often with the alum-water. By increasing the proportion of pearl ashes, the red may be rendered yet paler: but it is proper, when more than this quantity is added, to make the alum-water stronger.

These reds, when it is necessary, may be varnished as the yellows.

Of staining Wood blue.

Wood may be stained blue, by means either of copper or indigo: but the first will afford a brighter colour; and is more generally practicable than the latter: because the indigo can be used only in that state to which it is brought by the manner of preparation used by the dyers: of whom indeed it must be had, as it cannot be properly so prepared but in large quantities, and with a particular apparatus. The method of staining blue with the copper is therefore as follows.

Take of the refiners solution of copper made in the precipitation of silver from the spirit of nitre; or dissolve copper in spirit of nitre or *aqua fortis*, by throwing in filings or putting in slips of copper gradually, till all effervescence cease. Add to it of starch finely powdered, the proportion of one-fifth or sixth of the weight of the copper dissolved. Then brush the copper solution, while hot, several times over the wood. When this is done, make a solution of pearl-ashes, in the proportion of two ounces to a pint of water; and brush it hot over the wood, stained with the solution of copper, till it be of a perfectly blue colour."

Wood stained green as above by verdigrease, may likewise be made blue, by using the solution of the pearl-ashes in the same manner.

When indigo is used for staining wood blue, it must be managed thus.

‘ Take indigo prepared with soap-lees as when used by the dyers; and brush the wood with it boiling hot. Prepare then a solution of white tartar, or cream of tartar, which is to be made, by boiling three ounces of the tartar, or cream, in a quart of water: and with this solution, used copiously, brush over the wood before the moisture of the tincture of indigo be quite dried out of it.”

These blues may be rushed and varnished as the reds, where there is occasion.

Of staining Wood of a mahogany colour.

Mahogany colour is the most useful of any stain for wood (especially since the veneering with different colours is out of fashion) as it is much practised at present for chairs and other furniture made in imitation of mahogany; which, when well managed, may be brought to have a very near resemblance.

This stain may be of different hues, as the natural wood varies greatly, being of all the intermediate tints betwixt the red brown, and purple brown, according to the age, or sometimes the original nature of different pieces.

For the light red brown, use a decoction of madder, and fustic wood, ground in water; the proportion may be half a pound of madder, and a quarter of a pound of fustic, to a gallon: or in default of fustic, an ounce of the yellow berries may be used. This must be brushed over the wood to be stained, while boiling hot, till the due colour be obtained; and, if the wood be kindly grained, it will have greatly the appearance of new mahogany.

The same effect nearly may be produced by the tincture of dragon's blood, and turmeric root, in spirit of wine, by increasing or diminishing the proportion of each of which ingredients, the brown

stain may be stained to a more red or yellow cast at pleasure. This succeeds better upon wood which has already some little tinge of brown, than upon whiten. The color and strength will be as before.

For the dark mahogany, take the infusion of madder made as above, except the exchanging the suttie for two ounces of logwood; and when the wood to be stained has been several times brushed over, and is again dry, it must be slightly brushed over with water in which pearl-ashes have been dissolved, in the proportion of about a quarter of an ounce to a quart.

Any stains of the intermediate colours may be made by mixing these ingredients, or varying the proportion of them.

Where these stains are used for better kind of work the wood should be afterwards varnished with three or four coats of seed-lac varnish; but for coarse work the varnish of resin and seed-lac may be employed, or they may be only well rubbed over with drying oil.

Of staining Wood green.

Dissolve verdigrease in vinegar, or crystals of verdigrease in water; and, with the last solution, brush over the wood till it be duly stained.

This may be rubbed and varnished as the above.

Of staining Wood purple.

Brush the wood to be stained several times with a strong decoction of logwood and brazil, made in the proportion of one pound of the logwood, and a quarter of a pound of the brazil, to a gallon of water; and boiled for an hour or more. When the wood has been brushed over till there be a sufficient

body of colour, let it dry; and then be slightly pass-
ed over by a solution of one drachm of pearl-lithes in
a quart of water. This solution must be carefully
used, as it will gradually change the colour from a
brown red, which it will be originally found to be,
to a dark blue purple; and therefore its effect must
be restrained to the due point for producing the col-
our desired.

This may be varnished as the rest.

Of staining Wood black.

Brush the wood several times with the hot decoction of logwood made as above; but without the
brasil. Then having prepared an infusion of galls,
by putting a quarter of a pound of powdered galls
to two quarts of water, and setting them in the
sun, or on any other gentle heat, for three or
four days, brush the wood three or four times over
with it: and then pass over it again, with a solution
of green vitriol in water, in the proportion of two
ounces to a quart.

The above is the cheapest method: but a very fine
black may be produced, by brushing the wood sever-
al times over with a solution of copper in aqua-fortis;
and afterwards with the decoction of logwood,
which must be repeated till the colour be of sufficient
force; and the greenness, produced by the solution
of the copper, wholly overcome.

These blacks may be varnished as the other
colours.

Brush the wood to be stained several times with
strong decoction of logwood and brasil, made in the
proportion of one pound to two quarts of water.
Where the stains are desired to be very strong, as
in the case of wood intended to be used for veneer-
ing, it is, in general necessary, they should be soak-
ed in the decoction of logwood and brasil, for several
days.

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ed, and not brushed: to render which the more practicable, the wood may be previously slit, or sawed, into pieces of proper thickness for inlaying.

It is to be understood also, that when the wood is above ordered to brushed several times over with the tinging substances, it should be suffered to dry betwixt each time.

Of staining Ivory, Bone, or Horn.

Of staining Ivory, Bone, or Horn, yellow.

Boil them first in a solution of allum, in the proportion of one pound to two quarts of water: and then prepare a tincture of the French berries, by boiling half a pound of the berries, pounded, in a gallon of water with a quarter of a pound of pearl-ashes. After this tincture has boiled about an hour, put the ivory, &c. previously boiled in the allum water, into it; and let them remain there about half an hour.

If turmeric root be used, instead of the French berries, a brighter yellow may be obtained; but the ivory, &c. must in that case be again dipt in allum water after it is taken out of the tincture; otherwise an orange colour, not a yellow, will be produced from the effect of the pearl-ashes on the turmeric.

Of staining Ivory, Bone, and Horn, green.

They must be boiled in a solution of verdigrease in vinegar; or of copper in aquafortis, prepared as before directed, (a vessel of glass or earthen-ware be-

ing employed for this purpose,) till they be of the colour desired.

Of staining Ivory, Bone, and Horn, red.

Take strong lime-water, prepared as for other purposes; and the raspings of Brasil wood, in the proportion of half a pound to a gallon. Let them boil for an hour; and then put in the ivory, &c. prepared by boiling in alum-water in the manner above directed for the yellow; and continue it there till it be sufficiently coloured. If it be too crimson, or verge toward the purple, it may be rendered more scarlet, by dipping again in the alum-water.

Of staining Ivory, Bone, and Horn, blue.

Stain the ivory, &c. first green, according to the manner above directed; and then dip it in a solution of pearl-ashes made strong and boiling hot: but it must not be continued longer, nor dipt oftener, than is necessary to convert the green to blue.

The ivory, &c. may otherwise be boiled in the tincture of indigo prepared as by the dyers; and afterwards in the solution of tartar, made as is directed for the staining wood.

Of staining Ivory, Bone, and Horn, purple.

Treat them in the same manner as was directed for red; except that logwood must be substituted in the place of Brasil wood; and the use of the alum-water must be omitted wholly.

If a redder purple be wanted, a mixture of the logwood and brasil must be employed, instead of the

logwood alone. — The proportion may be equal parts, or in any proportion of the brash, according to the colour desired.

Of staining Horn to imitate tortoise-shell.

The horn to be stained must be first pressed into proper plates, or scales, or other flat form; and the following mixture must then be prepared.

“Take of quicklime two parts, and of litharge one; and temper them to the consistence of a soft paste with soup-lye.”

Put this paste over all the parts of the horn, except such as are proper to be left transparent, in order to the greater resemblance of the tortoise-shell. The horn must then remain thus covered with the paste till it be thoroughly dry: when the paste being brushed off, the horn will be found partly opaque, and partly transparent, in the manner of tortoise-shell; and when put over a foil, of the kind of latten called *affiche*, will be scarcely distinguishable from it. It requires some degrees of fancy, and judgment, to dispose of the paste in such a manner, as to form a variety of transparent parts of different magnitudes and figure, to look like the effect of nature; and it will be an improvement to add semi-transparent parts. This may be done by mixing whitening with some of the paste to weaken its operation in particular places: by which spots of a reddish brown will be produced; that, if properly interspersed, especially on the edges of the dark parts, will greatly increase as well the beauty of the work, as its similitude with the real tortoise-shell.

To stain Ivory, Bone, and Horn, black.

Proceed in the same manner as is above directed for wood.

Of staining Paper, or Parchment, of various Colours.

Of staining Paper, or Parchment, yellow.

Paper may be stained yellow by the tincture of French berries, but a much more beautiful colour may be obtained by using the tincture of turmeric, formed by infusing an ounce or more of the root, powdered, in a pint of spirit of wine. This may be made to give any tint of yellow, from the lightest straw to the full colour, called French yellow, and will be equal in brightness even to the best dyed silks. If yellow be wanted of a warmer or redder cast, annatto, or dragon's blood, may be added to the tincture.

Of staining Paper, or Parchment, red.

Paper, or parchment, may be stained red, by treating it in the same manner as is directed for wood, or by red ink. It may also be stained of a scarlet hue by the tincture of dragon's blood in spirit of wine: but this will not be bright.

A very fine crimson stain may be given to paper, by a tincture of Indian lake, which may be made, by infusing the lake some days in spirits of wine, and then pouring off the tincture from the dregs.

Of staining Paper, or Parchment, green.

Paper, or parchment, may be stained green, by the solution of verdigrease in vinegar, or by the crystals of verdigrease dissolved in water. As also by the solution of copper in aquafortis, made by adding filings of copper gradually to the aquafortis till no ebullition ensues; or spirit of salt may be used in the place of the aquafortis.

Of staining Paper, or Parchment, blue,

A blue colour may be given to paper, or parchment, by staining it green by any of the above-mentioned methods; and treating it afterwards as is directed for the staining wood blue, by the same means; or by indigo, in the manner there explained likewise.

Of staining Paper, or Parchment, orange.

Stain the paper, or parchment, first of a full yellow, by means of the tincture of turmeric; as above directed. Then brush it over with a solution of fixt alkaline salt, made by dissolving half an ounce of pearl ashes, or salt of tartar, in a quart of water, and filtering the solution.

Of staining Paper, or Parchment, purple.

Paper, or parchment, may be stained purple by orcheal: or by the tincture of logwood, according to the method before directed for staining wood. The juice of ripe privet berries expressed will likewise give a purple dye to paper or parchment.

Of staining Alabaster, Marble, and other Stones, of various colours.

Alabaster, marble, and other stones, may be stained of a yellow, red, green, blue, purple, black, or any of the compound colours, by the means above given for staining wood. But it is better, when a strong tinge is wanted, to pour out the tincture, if

made in water, boiling hot on the alabaſter, &c. ſpreading it equally on every part, then to brush it over only; though that may be ſufficient where a lighter dye will ſuffice. When tinctures in ſpirit of wine are uſed, they muſt not be heated; as the ſpirit would evaporate, and leave the tinging gums in an undiſſolved ſtate.

Where ſtones are not perfectly white, but partake of brownneſs or greyness, the colour produced by the tinges will be proportionably wanting in brightneſs. Becauſe the natural colour of the ſtone is not hid or covered by theſe tinges; but combines with them: and, for the ſame reaſon, if the ſtone be of any of the pure colours, the reſult will be a compound of ſuch colour and that of the tinge.

The Art of ſtaining Glaſs.

To tinge Glaſs of a deep red.

Opake colours have a body; but the transparent ones none; for which reaſon this deep red muſt be mixed with matters that give it one as ſhall be ſhewn. Take twenty pounds of cryſtal frit, one pound of calcined tin; mix the whole well together, and put it into a pot, and ſet it in a furnace that it may purify. When it is melted, caſt in an ounce of calcined ſteel well pounded, and an ounce of ſcales of iron from the anvil well pulveriſed and mixed together; keep ſtirring the glaſs well with an iron ſtirrer, while you are putting in the powder to hinder it from riſing too much. You muſt take care not to put in too much of the powder, for that would make the glaſs black, whereas it ought to be clear, ſhining, and of an obſcure yellow; then take about fix drachms of

calcin'd copper prepared, cast it upon the melted glass, often mixing it two, three, or four times, and the glass will be as red as blood. If the colour be as you would have it, you must work it off presently, for fear it should turn black, and the colour be lost, of which great care must be taken; but if, notwithstanding this, the colour comes to be lost, you must add more scales of iron in powder, and it will return.

To make a Peach colour in Glass.

To make this colour, which is a very agreeable one, take glass prepared and ringed of a milk white, and, when it is in good fusion, put in some manganese of Piedmont prepared, and that by little and little, stirring the matter well at each time, till the colour become, as fine and as perfect as you desire it; but you must work the glass in time, otherwise the colour will be lost; but by so doing you will have a very fair peach-colour.

To make a gold-yellow in Glass.

Gold colour, being one of the the most noble and finest we can make, by reason of its imitating the most perfect metal in nature, must be made with the purest materials and greatest precaution. Take two parts of crystal frit, made with tarso, and not with sand, which is not so good; and one part of frit, composed of two thirds of tarso, and one third of fine salt of polverine prepared; pound and mix them well, and, to each fifty pounds of this composition, add half a pound of tartar purified, and pounded fine, and half a pound of manganese of Piedmont prepared, mixing these powders well with the two frits, because you must not cast them on the melted glass, as in other colours. Then put the whole, by little and little, into a pot and let them in a furnace,

in which let them stand at an ordinary fire four days, for fears the glass rising should run over. When the matter is well purified, you may use it for making vessels and what other works you please, which will be the fair colour. If you have a colour yet clearer, you must add more powder, and you will have a very fine golden colour. If you will have it yet finer, take fine crystal frit, made of pulverine of rochetta, and the golden colour will be yet more fair.

To make a milk-white colour in Glass.

Take twelve pounds of good crystal frit, two pounds of calx of lead and tin, one of each, and half an ounce of manganese of Piedmont prepared; the whole being pulverised and mixed together, put them into a pot heated in the furnace: let it stand there for twelve hours; then mix the whole well, and make an essay of it. If the colour does not please you, add to it some calx of the two metals before mentioned, which incorporate with the glass, mixing it well. In eight hours after, the glass will be fit to work, and as white as milk.

To give Glass the colour of lapis lazuli.

Lapis lazuli, which is a fine blue, and full of veins of gold, will not be easy to imitate, without a great deal of care and industry in its preparation. To make this fine colour you must use the same matter as for the fine white; and when it is in fusion in the pot, you must add to it, by little and little, the blue enamel in powder, which is made use of by painters, mixing the whole well together each time, and that as often as there is occasion to make this colour: then try it, whether the colour is to your mind, and

make a second essay of it; if the colour be perfect, let it stand ten hours, and then mix it again. If it keeps in the same state, without changing the colour, you may employ it in making what vessels you please, which will be of the true colour of Lapis lazuli. If in working this glass it happen to rise, you may cast in a little leaf gold, which will make the glass approach yet nearer to Lapis lazuli, and which will in a moment stop the rising of the metal, as sugar will do in boiling oil.

To make a marble colour in Glass.

White marble, being very simple, it is easy to imitate; the way of doing it only requires crystal frit, which must be wrought as soon as it is melted, before it be purified, for so it will give a very fair marble colour.

CHAP. XXIII.

D Y I N G.

The Method of making a Vat; and preparing hot Suds for dying Linen and Woollen Blue.

HA V I N G made a vat big enough to contain eight pails of water, wide at the top, and narrow at the bottom; season it for a day and night with hot water, and afterwards wash it out with cold; then cut a four square at about the height of twenty-one inches, and fourteen broad; and have a copper plate made of the same thickness with the wood of the vat; nail this upon the hole, placing the nails at the distance of the breadth of two fingers one from the other; the nails must be small, with

broad heads, to prevent its leaking; then place an iron hoop at the top, and another at the bottom of the copper: the hole must be made about a hand's breadth from the bottom of the vat. When this has been done, plaister or brick it about, either leaving or making a hole in the plaister or brick work, wider at the utmost end, and a little narrower at that which comes to the copper itself; the shape of it being like an oven's mouth, that the wood be not injured, when the fire, to heat the vat of fuds, is put into this vacancy.

For every half pound of indigo you put in, in order to blue linen or woollen, take in eight pails of water, and into that six handfuls of coarse wheaten bran, eight or nine ounces of madder, a pound and a half of pot-ashes; pour them all into a copper to make fuds, and, when the liquor boils so as to begin to swell and bubble up, throw in two or three quarts of cold water, and rake out the fire from under the copper. Then having ready lime, prepared as the tanners use it, plaister the inside of the empty vat with a handful or two of it, and afterwards pour all the ingredients out of the kettle into it, and cover it very close.

The day before you do this, you must put your indigo to dissolve in a quart or three pints of water, in a clean vessel of iron or brass, adding half a handful of wheaten bran, and half a handful of madder, and half an ounce of pot-ashes, and leave it a whole night over a coal fire; but it must not be suffered to boil, or grow hotter, than you can bear your hand in it.

You must also grind it with a pestle or iron ball till it becomes as soft as pap, and is quite cleared of all roughness or harshness; which being done, it is fit to be put into the vat to the other ingredients. Then stir it about three or four times with a stick, then cover it up close, and let it stand to settle six hours; after which throw in a ladleful of lime-dust, or powder, or of the same that you before plaistered

the vat with, then cover it, close again, and let it stand for three hours longer, and then put in half an ounce of pot-ashes; stir it well about again, and put a coal fire in the hole before the copper plate, in order to keep it warm, and let it stand three hours longer; after which, nothing is to be added, only stir it as before, and, in an hour or two after, you may dye with it as follows.

Hang five pieces of goods in it, keeping the bran and flour, &c. from it with your hand, to prevent its touching the linen as much as possible; wring the five pieces out one against another, then try, by feeling with your finger, whether the dye be harsh, or soft and smooth; if it feels too rough, throw in half an ounce of pot-ashes; and if it be too smooth, add a ladleful of lime. Work the cloth or linen in it for two hours, put in five fresh pieces, and work them like the former; and, when they are dry, wring them a second or third time in the dye, till they become of a colour as deep as you would have them.

Your dye may be wrought in this manner, till you have dyed thirty pieces; and afterwards, if you would dye any woollen ware, stockings, or yarn, take two pailfuls of water, into which put two handfuls of wheaten bran, an ounce of madder, and a quarter of a pound of pot-ashes; and hang it over the fire and boil it to the luds as before; then put it into the vat, and, after you have stirred it well about, let it stand to settle three hours; then try with your finger whether it is harsh or smooth; if it be too harsh, add half an ounce of pot-ashes; and, if too smooth, add half a ladleful of lime, and stir it again.

If you would dye woollen ware alone, without linen, prepare a liquor of a sufficient quantity of hot water, a handful of madder, and a handful or two of wheaten bran; boil them together, and wet the

filken or wollen therein, hang them up, and let them drop as long as they will; then put them into the above mentioned dye-vat, letting them lie there till they are tinged of as deep a colour as you would have them.

A blue dye for Silks.

Procure a tub that may be close covered, put into it a ley made of three pailfuls of river or rain water, and clean beech ashes; put in also, two handfulls of wheaten bran, two ounces of madder, two ounces of white wine tartar, and half a pound of indigo pounded small; stir it very well with a stick every twelve hours, for fourteen days, till it tinges a sort of green, and when the dye is grown bright, it must be stirred every morning. Put the silk into a warm fresh ley, wring it out and then stir it about in the dye some time afterwards, letting it hang in the dye, according to the custom of dying; and besides the blue copper, there ought to be another copper full of ley, that when the silk is wrung out of the dye, it may be rinsed in it; and, after it has been wrung very clean out of that, rinse it again in river water, beat it and dry it. If the silk be moistened in this latter ley fuds, before it is dried, there is no need of the first above mentioned ley.

Several sorts of blue may be made with this dye, either brighter or darker, at pleasure, according to the time they are left in it; and when the copper grows low, you may fill it up again out of the rinsing vat; but when the blue copper or vat grows weak, then put in a quarter of a pound of pounded indigo, and half a pound of pot-ashes, half an ounce of madder, a handfull of wheaten bran, and a quarter of an ounce of tartar pounded; let it stand eight days without using it, stirring it every twelve hours, and then you may dye with it again as before.

Of dying Red colours.

Take lixivium of unslacked lime five gallons, brasil ground two pounds and a half, boil it to the half, then put to it allum twenty ounces; keep it warm, but not to boil: then what you would dye in this colour dip it into a ley made of ashes of tartar, letting it dry, then dip it into the ley,

To dye a red blush colour.

Take stale clear wheat bran liquor six days old, a sufficient quantity; allum three pounds and a half, red tartar half a pound; melt these and enter twenty yards of broad cloth; handle and let it boil three hours, take it out and wash it well, but some wash it not: take fresh liquor a sufficient quantity, of the best madder three pounds; enter your cloth, and handle it to a boiling heat, cool and wash it again: lastly, take fresh bran liquor a sufficient quantity, enter your cloth, let it boil a quarter of an hour, cool and wash it well again.

To make a red blush colour in grain.

Take stale four clear bran liquor, a sufficient quantity; allum three pounds and a half, red tartar half a pound; enter twenty yards of cloth, boil it three hours, cool and wash it, take fresh clear bran liquor a proper quantity, best madder three pounds, enter and boil again: take fresh bran liquor a sufficient quantity, grains in fine powder four ounces, red tartar three ounces; enter your cloth, boil it an hour or more, keeping your cloth well under the liquor, then cool and wash it well.

A red rose or carnation colour.

Take wheat bran liquor, a sufficient quantity, alum two pounds, tartar two ounces; boil and enter twenty yards of camblet or cloth, and boil it three hours, after which take it out, and wash it very well; then add madder a pound, enter and boil it again, cool and wash it; after which take clear liquor a sufficient quantity, cochineal in fine powder two ounces, tartar two ounces; enter your cloth, boil and finish it.

To dye Silk red.

For every pound of silk put four handfuls of wheat-bran into the quantity of two pails of water; boil them together, and pour the liquor in a tub, and let it stand all night, clarify it, and put into the water half a pound of alum, and a quarter of a pound of tartar of red wine reduced to an impalpable powder; add also half an ounce of turmeric, reduced to a fine powder; boil them together for a quarter of an hour, stirring them very well; then take the kettle off the fire, and immediately put in the silk, and cover the kettle very close, that none of the steam may evaporate: let it stand thus for three hours, then take out the silk, and rince it very well in cold water: then beat it very well upon a block, and let it dry. Then beat a quarter of a pound of galls small, put them into a pail of river or rain water; boil them for a full hour, then take the kettle off the fire, and when it is grown cool enough for you to endure your hand in it, put in the silk, and let it lie and steep in it for an hour, then take it out and dry it. For every pound of silk, allow one pound of brasil, boil it, and strain it; then boil the wood again, adding cold water to it; wave or turn the silk about in it, take it out of that without wringing, when it has

sufficiently imbibed the tincture; then add a little pot-ashes, or put them into cold water, and turn the silk up and down in it, and when it is red enough rince and dry it.

To dye a very fine crimson.

For sixteen pounds of woollen stuffs boil twelve gallons of water, or rather more; to which put in sixteen handfuls of wheaten bran; let it stand a night to settle, stirring it very well, and in the morning pour off the clear liquor, or rather strain it, that it may be perfectly clear: mix one half of this liquor with as much clean water that the cloth or stuffs may be worked commodiously in it. Boil this mixed liquor, and put into it one pound of allum, and half a pound of tartar; boil these very well, and then put in the goods and boil them for two hours, keeping them stirring (especially if they are made of wool) from top to bottom continually, to finish it. Boil the remainder of the bran and water with an equal quantity or rather more of fair water, and, when it boils apace, put in four ounces of cochineal, and two ounces of pure white tartar powdered; stirring it about and taking care that it neither runs over, or boils too fast; and, when it is very well boiled, put in your ware, and stir it about till you find that it has taken the dye equal every where; then cool and rince them out.

To dye Silk a crimson.

The silk having been prepared as before directed, allow an ounce and an half of cochineal to every pound of silk, pound it to powder, and pass it through a hair sieve; then put it into the remaining pail of liquor last mentioned, and hang it over the fire again; then with the liquor put it into a brass kettle, and co-

ver it very close that no dust may get in; hang it over the fire again, and add to it an ounce and a half of white arsenic, and two ounces and a half of tartar, both reduced to a fine powder; boil them together for a quarter of an hour; then take it off the fire, and put in the silk, stirring it about very well, that the colour may not be variegated, when the liquor is cold; then wring out the silk, and, if it is not tinged enough, hang the dye over the fire again; and after the silk has been beaten, put it in again as before. When the silk is dyed you must in the first place rinse it out in hot suds, made by putting half a pound of Venice soap, in proportion to every pound of silk; let it be dissolved in it, and afterwards put the silk into cold river water; then beat it upon a block and hang it to dry; then spread it abroad, and manage it according to custom, and it will be a beautiful crimson. If you would dye crimson from a violet ground, you may always abate one third part of the quantity of the ingredients; that is, a pound of silk, so grounded, will not require above an ounce of cochineal, as much of arsenic, and two ounces of tartar.

To dye silk a Dove crimson.

The silk having been allumed, as above directed, clean rinsed and hung upon poles, take a little, scour it very clean, fill it with water, and to each pound of silk put an ounce of cochineal; stir the silk in the liquor, and boil them for an hour; then rinse the silk out, wring and dry it. You must take special care that the silk is not partly coloured in by different colours, by taking the colour's better in one place than in another; and for that reason it must be put in when the liquor is no more than lukewarm.

To dye Silk an orange crimson.

Put clean rain water into a very clean kettle, then put four ounces of pot-ashes, and four ounces of orleans; strain them through a sieve into the kettle, and dissolve them very well: the boiled and allumed silk, being first well rinsed from the allum, must be stirred about in it and boiled, then wrung out, rinsed and beaten; then to every pound of silk take twelve ounces of galls, which boil two hours, and then let them cool for two hours, and afterwards lay the silk to soak in it for three or four hours; after which take it out, wring, rince, beat and dry it.

To dye Black.

For stuffs of little value, it is sufficient that they be well blued with pastel, and blackened with galls and copperas; but no stuffs can be regularly dyed from white into black, without passing into the intermediate blue: yet there is a colour called cold black, or Jesuits black, but without being first dyed blue. In this case the drugs are dissolved in water, that has boiled four hours, and stood to cool till the hand can bear it; then the stuff is dipped in again and again, and taken out six or eight times.

To dye black upon blue.

Take a about nine or ten gallons of water, as many ounces of nut galls beaten: wool, woollen yarn, woollen cloth or flannel, to the weight of about three pounds: let them be boiled for four hours, after which, take the matter out and open them to the air; then put into the liquor eighteen ounces of green copperas; and if there be not liquor enough left, put in more water, as much as will cover the stuffs,

&c. and boil it for two hours, handling it continually: then take it out again and air it, and put it in again till it is black enough; after this cool and wash it;—but take notice, if you put in some linnach with the galls, it will make a better black.

To recover the colour of black cloth when decayed.

Boil the leaves of fig-trees well in water, wash the cloth in it, dry it in the sun, and it will be a much fairer black.

To dye Silk black.

Pour three pails of water into a copper, and add two pounds of beaten galls, two pounds of linnach, and two ounces of madder, four ounces of antimony reduced to an impalpable powder, two of oxgall, one ounce of madder, one ounce of tragacanth; let them dissolve a proper time, and then put in a proper quantity of dry elder-bark powdered, two pounds of vitriol, and twelve ounces of filings of iron; then pour off the water, and let them boil together two hours; after which, fill it up with half a pail full of barley, or rather malt water, which is drawn off by brewers; after boiling again half an hour, put in the silk; let it boil gently for half an hour, then take it out and rinse it in a copper full of water, and throw it again into the dye; and, afterwards, when you take it out, rinse it very clean in river water; hang it up in the air to dry, then put it into the dye again, and boil it gently for half an hour, rinse it in the copper as before, and afterwards in river water, and, when it is dry, take gold-leaf, and add two ounces of pot-ashes; rinse the silk very well in this liquor, and, lastly, in river water, then dry it, &c.

An additional improvement to the former dye.

Having dyed silks black, as before, take sal-armo-
niac and antimony powdered two ounces, filings of
iron two handfuls; put them together in a copper,
that has been drawn off, and hath been used before,
make it so hot that you can but just bear your hand in
it, that this additional dye may the better penetrate:
then take the black silk, having been well dried,
and put it into the copper; let it lie there for an
hour, till it is thoroughly moistened; then draw it
through water, in which a proper quantity of gum
tragacanth has been dissolved, taking care that it be
thoroughly wetted: then dry it as usual.

To give a lustre to black silks.

After the silk has been dyed, for every pound of it
take an ounce of isinglass, which steep in water, and
pass the silk through the liquor, and it will be of a
very beautiful lustre.

*A black dye for re dyeing Hats, or any thing that has
lost its black colour.*

Take half a pound of blue Provence wood, boil
it in a pint of strong beer, till half of it be consu-
med; then add half a pound of vitriol, and an ounce
of verdigrease; take out the wood, and put in a
quarter of an ounce of gum tragacanth; let it stand,
and when you have occasion to use it, dip a little
brush in it, and so streak it over the hat or silk, and
it will give a fine lasting black.

A good yellow dye for Silks, &c.

First boil the cloth or stuff in allum and pot ashes,
and rince it out, then procure a clean kettle, put in

a sufficient quantity of water, and for every pound of silk put in two pounds of yellow wood, and six ounces of galls; let the yellow wood boil an hour before you put in the galls, and afterwards boil them together for half an hour, and then put in the silk, stirring the dye: then wring it out of the kettle with a little pot ashes, and, after it has been wrung out, put it into the dye again, and leave it there to soak for a whole night, and in the morning rinse, beat, and dry it.

To dye Stuffs a brimstone yellow.

Boil the stuff in three pounds of allum, one pound of tartar, and three ounces of salt, for an hour; throw away the water, then make a liquor of yellow brown, laying it in the same order as straw in brew-houses; then add ley ashes, and draw the stuff through the dye three or four times very quick: to do which dexterously it will require the assistance of three or four men.

To dye Thread yellow.

Boil eight pounds of broom, one pound of Spanish yellow, one pound of crab-tree rind, and one pound of corn marigold in a kettle, with three quarts of sharp ley; and work the thread in the liquor three times successively, not suffering it to dry between whiles, and it will be of a beautiful and lasting colour.

To dye Stuffs a straw-colour.

First dye the goods yellow, and throw half a pint of urine into the dye: put in the goods, and work them about, as long as you think convenient.

To dye Silk a straw-colour.

First allum and rince the silk, and for every pound of it boil one pound of broom flowers for a quarter of an hour; then pour it into a tub, which must be in size proportionable to the quantity of silk; then put to it an equal quantity of water, and, after you have stirred the silk in it, fill the kettle again with water and boil it half an hour: the silk being wrung out of the first suds, put them into the second; and if you see occasion, make a stronger yet, and stir the silks in it, till the colour is sufficiently heightened; then rince it, and hang it up to dry.

To dye Silk an orange-colour.

First lay the white silk in allum-water, in the same manner as the yellow; then take the eighth part of a pound of orleans, dissolve it in water for the space of one night, add to it one ounce of pot-ashes; boil it for an hour, then add an ounce of beaten turmeric, stir it very well, let it stand a little while, and then put in the allumed silk, and let it remain there, one, two, or three hours, according as you would have the colour light or dark: rince it in fine soap suds, till it is perfectly clean; then beat and dry it.

To dye Silk a gold colour.

This must be dyed after the same manner as the straw-colour is, only when it is become reasonably deep, put it into the last suds of the orange liquor, and stir it therein so long, till you are sure it is grown deep enough; then rince it out and dry it, then rince it in clean water, and when it is dry, throw it into the blue you may have for the allum.

To dye Stuff a gold colour.

Let the stuff be first dyed yellow, then set fresh water over the fire, and for every pound of ware use an ounce of fustel-wood, called also yellow shavings, and a good quantity of coarse pot-ashes; let the dye boil for half an hour, and afterwards work the stuff in it.

To dye Wollen stuffs green.

First dye the stuffs yellow with broom or dyeweed, rince them well out, and while they are wet pass them through the blue dye, and work it, till it is the colour you would have it, either light or dark, so that several shades or sorts of green may be dyed the same way, the stuffs having been always tinged with yellow.

For ever
verdigrease powdered, three parts
wine vinegar, stir the verdigrease in it;
of stockings through the liquor, and hang them out without rincing: when they are dry, wet them in the liquor again, and hang them up to dry again, so often, till they are perfectly cleared from all humidity.

To dye a brown or iron green.

For a piece of stuff fifteen ells, take twelve ounces of allum, half a pound of tartar, two ounces of calcined vitriol; in these boil the stuff for half an hour, then rince it in clean water; and when it is dried for the blue you may throw away the allum

suds. How to blue it. The ware being blued with woad of a light or deep brown according to your mind, then rince it again, dry it, and prepare it for the following yellow. Boil eight pounds of broom for half an hour, keeping it down in the kettle with a stick, that it does not float on the top of the water; and, when you use it, add two quarts of sharp ley, half an ounce of flour of brimstone, and an ounce of verdigrease; then dye the goods but only once, and it will be of a beautiful brown or iron green.

To dye Linen green.

Lay the linen a whole night in strong allum-water, dry it well, then boil broom or dyers weed, for the space of an hour; take it out, and put into the suds either half or a whole ounce of verdigrease, according to the quantity of the ware you have to dye; stir it well about with a stick, and then work the linen in it once, twice, or thrice, as occasion requires, adding, the second and third time a quantity of pot-ashes equal to an hen's egg; then work your linen a third time, and you will find it of a yellow colour; then dry it in the air, and afterwards throw it into the blue vat (see blue) and that will produce the green you desire,

To dye thread of a lasting green.

Boil three quarters of a pound of allum, half a pound of tartar, in two quarts of sharp ley for an hour, and in it soak the thread for three hours keeping it hot all the while: how to dye it yellow: put into the kettle eight pounds of broom, one pound of corn marigold flowers, half a pound of crab-tree bark, that looks yellow and ripe, and su-

per-add two quarts of sharp ley: when these have boiled half an hour, then dye the thread in the liquor as deep a yellow as possible: but if you can procure Spanish Yellow, an addition of three quarters of a pound of it will heighten the dye, and render it more lasting: for it is to be remembered, that all yellows, that are designed to be dyed green, must be as deep as possibly they can be. After this turn it green with blue dye. You may blue the thread with woad, else with Indigo, being first thrown into the allum-suds, and afterwards into the yellow, and you will have a lasting green, so that a green is to be dyed several ways.

Greens for Silks.

For every pound of silk take a quarter of a pound of allum, two ounces of white wine tartar beaten small; dissolve them together in hot water, then put in the silk, letting it lie a whole night: then take it out and dry it; having done this, take a pound of broom, boil it in a pail and a half of water for an hour or better: then take out the broom and throw it away, and put in half an ounce of beaten verdigrease, stirring it about with a stick: then put in the silk for a quarter of an hour, take it out and let it lie till it is cold; then put in one ounce of pot-ashes, stir them about and put in the silk again, keep it there till you think it is yellow enough, then rinse it out and let it dry: after which put it into the blue dye vat or copper, and let it remain there till it becomes green and dark enough; then take it out and you will have a good green: then let it be beaten and dried. You may let it lie a longer or lesser while in the dye, according as you would have the green lighter or darker, for at first you will have but a faint green.

Grass Green.

First dye your silk a pretty deep straw colour, since it is clean and wring it close together with sticks; and then put your silk into the blue dye copper: though you must take care that the strength of the dye be proportioned to the quantity of silk, and that you do not put in too much silk at once. When it has boiled enough take the kettle off, and let it stand for an hour, after which time you may work it again, and do the same every hour, allowing the same interval, but you must be very careful that one handful of silk does not lie longer in than another, and when it is taken out of the copper, let it be very well cooled, rinsed, and strongly wrung with sticks, and afterwards dried.

To dye a parrot or parroquet Green.

This being something lighter than the other, must be boiled in weaker suds than the other, and, as soon as it is dyed, must be wrung and dried as the other.

To dye green Finch or Canary-bird Green.

This must be dyed as the green; only the last suds must be encouraged with a little provence wood suds, till it is deep enough; then wring it out, &c. as above.

To dye a Caledon or Celadine Green.

This colour, being very light and bright, must be dyed as the sea-green, and boiled in weak suds, and managed as the green, and dried.

To dye a Sea-Green.

For every pound of silk take three ounces of verdigrease pounded small, put it into good white wine, or sharp vinegar to dissolve: let it lie a whole night in it, in the morning set it over the fire and make it hot, stirring it about with a stick; and then put in the silk, but take care not to let it boil; and let it remain two hours, or one, or half an hour according as you would have the colour a deep, middling, or light green; then put some boiling hot water into a vat or tub, to which add half an ounce or an ounce of soap, and make a lather: when it froths it is ready: then hand the silks in it, let them drop afterwards, and rince them in river water, beat them very well and dry them.

To dye Stuffs, &c. Purple.

Allow a sufficient quantity of fair water to every pound of stuff: one pound of tartar, and two ounces of allum, in which boil the cloth for an hour; then take it out, cool, and rince it: after this warm some clean water, into which put in three ounces of brasil wood, boil it half an hour, and then work the stuffs in it, till they become as red as desired: Upon which, take them out, and put into the dye two ounces of pot-ashes; stir it well about, and put in the red stuff once more; roll it off, and on the roller, that it con not spot, then cool and rince it out.

To dye Silks a slight Purple.

Put the silk into a slight red dye, but increase the quantity of pot-ashes, to turn it to purple; then rince, and dry it.

To dye Thread of a Purple Colour.

First allum the thread with three pounds of allum, half a pound of tartar, and two ounces of brasil; dry it, and draw it through the woad or indigo dye; then rince it clean and dry it again; then, to brown or deepen it, take twelve ounces of brasil, being, first boiled; which liquor divide into three parts, to be used at three times. To the first add half an ounce of Paris red, a sort of sandarach, one drachm of mastick, and a quarter of an ounce of calcined tartar; always drying the thread after you have used every one of the parts of the liquor. The second time add half an ounce of turmeric, two drachms of cinnabar, and half an ounce of gum arabic. The third time, when the thread becomes reddish, add a quart of sharp ley, and by this means the thread will be dyed of a lasting colour.

To dye a Scarlet Colour in Grain.

Take stale clear wheat bran liquor, a sufficient quantity, allum three pounds: enter twenty ells of broad cloth, and boil it three hours, cool and wash it: take fair water a sufficient quantity, hedder or strawel a fit quantity: let them boil well, cool them with a little water, enter your cloth and make a bright yellow, cool and wash it again: take fresh wheat bran liquor, a sufficient quantity: madder four pounds; enter your cloth at a good heat, handle it to a boiling, cool and wash it well: take more fresh bran liquor, cochineal in fine powder, five ounces; of tartar three ounces; enter your cloth, and boil it an hour or more, keeping it under the liquor, then cool and wash it.

To dye a deep Scarlet Flesh Colour.

For thirteen pounds of woollen ware take two pounds of aqua-fortis, tempered with half a pound of tin; two pounds and an half of white wine tar, half a pound of sal-gemmæ, four ounces of Sal-armoniac; boil the ware with all these for half an hour, then rince it out; and to finish it. Add one pound and a quarter of cochineal, one ounce of Sal-armoniac, boil the goods with these for a quarter of an hour, and they will be a very good colour.

A Liquor to scour Scarlet.

Boil a pound of wheaten bran in as much liquor as is sufficient to work ten or twelve pounds of ware; and afterwards add to it three ounces of allum, three ounces of Florence orris-root powdered; boil all together, pour them into a clean vat or cooler, and let them settle till the liquor is clear; afterwards heat the clear liquor in a kettle, and scour the scarlet with it, and it will have a good effect.

To dye Stuffs of an Olive Colour.

This must be ordered as the brimstone yellow, after which prepare fuds of galls and copperas, but not strong; through which pass the stuffs, and two or three times, according as you would have the dye lighter or deeper, and it will produce an olive colour.

Take the best indigo, and keep it in urine a day, then
boil it with allum, and it will be good, or temper the
indigo with water.

Dying of Leather.

To dye Leather of a reddish Colour.

First wash the skins in water, wring them well out, and afterwards wet them with a solution of tartar and bay-salt in fair water, and wring them out again; then to the former solution add ashes of crab-shells, and rub the skin very well with this; after this wash them in common water, and wring them out; then wash them with tincture of madder in the solution of tartar and allum and the crab-shell ashes; and if they prove not red enough after all, wash them with tincture of brasil.

To dye Leather of a pure Yellow.

Take of fine aloes two ounces, of linseed oil four pounds; dissolve or melt them, then strain the liquor, and besmear the skins with it, and, being dry, varnish them over or infuse wood in vinegar, in which boil a little allum; or thus, having died them green, as directed, then dye them in a decoction of privet-berries, saffron and allum water.

To dye Leather Blue.

Boil elder-berries or dwarf-elder in water, then smear or wash the skins with it; wring them out, then boil the berries as before in a solution of allum-water, and wet the skins in the same water once or twice, dry them, and they will be very blue. Or

take the best indigo, and keep it in urine a day, then boil it with allum, and it will be good; or temper the Indigo with red wine, and wash the skins with it.

To dye Leather of a pure Sky Colour.

For each skin take indigo one ounce, put it into boiling water, let it stand one night, then warm it a little, and with a brush pencil beimear the skin twice over.

To dye Leather Purple.

Dissolve roch allum in warm water, wet the skins with it, dry them, then boil rasped brasl well in water: let it stand to cool: do this three times, and afterwards rub the dye over the skins with your hand, and when they are ready polish them.

To dye Leather Green.

Take sap green and allum water, of each a sufficient quantity: mix and boil them a little: if you would have the colour darker, add a little indigo.

To dye Leather Black.

Take of the bark of elder two pounds, of the filings or rust of iron the same quantity, put them into two gallons of rain water, and stop them up close in a cask or vessel, and let them stand for the space of two months: then put to the liquid part a pound of nut-galls beaten to powder, and a quarter of a pound of copperas, heating them over the fire, and suffering them to stand twenty-four hours after, and then

use the liquor with a brush till the skin has taken a fine black.

To gild Leather.

Take glair of the whites of eggs, or gum-water, and with a brush rub over the leather with either of them, and then lay on the gold or silver, let them be dry, and burnish them.

To dress or cover Leather with Silver or Gold.

Take the colour called brown red, and grind it on a stone with a muller, adding water and chalk : and when the latter is dissolved, rub, or lightly daub the skins over with it, till they look a little whitish ; and then lay on the leaf silver or gold, before they are quite dry, laying the leaves a little over each other, that there may not be the least omitted ; and when they have well closed with the leather, and are sufficiently dried on and hardened, rub them over with a polisher made of smooth ivory, or of the foretooth of a horse, and it will appear very bright.

C H A P. XXIV.

Of the means of taking Casts and Impressions, from Figures, Busts, Medals, Leaves, &c.

TH E method of taking casts of figures and busts, as at present practised, is most generally by the use of plaister of Paris; or, in other words, alabaster calcined by a gentle heat. The advantage of using this substance preferable to others, consists in this, that notwithstanding a slight calcination reduces it to a pulverine state, it becomes again a tenacious and cohering body, by being moistened with water; and afterwards suffered to dry. By this means either a concave or convex figure may be given by a proper mould or model to it when wet, and retained by the hardness it acquires when dry: and from these qualities, - it is fitted to the double use of making both casts, and moulds for forming those casts. The plaister is to be had ready prepared of those, who make it their business to sell it, and the only care is to see that it is genuine.

The particular manner of making casts depends on the form of the subject to be taken. Where there are no projecting parts, it is very simple and easy; as likewise where there are such as form only a right or a greater angle with the principal surface of the body: but where parts project in lesser angles, or form curves inclined towards the principal surface of the body, the work is more difficult. We shall therefore first explain those particulars of the manner, which are general to all kinds; and then point out the extraordinary methods to be used where difficulties occur,

The first step to be taken is, the forming the mold; which is, indeed, done by much the same means, as the cast is afterwards made in it. In order to this, if the original or model be a bass-relief, or any other piece of a flat form, having its surface first well greased, it must be placed on a proper table, or other such support; and surrounded by a frame, the sides of which must be at such a distance from it, as will allow a proper thickness for the sides of the mold. A due quantity of the plaster, that is, what will be sufficient to cover and rise to such a thickness as may give sufficient strength to the mold, as also to fill the hollow betwixt the frame and the model, must be moistened with water, till it be just of such consistence as will allow it to be poured upon the model. The plaster thus moistened must then be put on the model as soon as possible: for it must not be delayed after the water is added to the plaster, which by another way of considering, it soon becomes more fluid, and is more unfit to be used. The whole must then be suffered to remain in this condition, till the plaster has attained its hardness, and then the frame being taken away, the preparatory cast or mold thus formed may be taken off from the subject intire.

Where the model or original subject is of a round or erect form, a different method must be pursued; and the mold must be divided into several pieces: or if the subject consists of detached and projecting parts, it is frequently most expedient to cast such parts separately; and afterwards join them together.

Where the original subject or model forms a round, or spheriod, or any part of such round, or spheriod, more than one half the plaster must be used without any frame to keep it round the model; and must be tempered with water, to such a consistence, that it may be wrought with the hand like very soft paste. But though it must not be so fluid, as when prepared for flat-figured models, it must yet be as moist as

if compatible with its cohering sufficiently to hold together. Being thus prepared, it must be put upon the model, and compressed with the hand, or any flat instrument, that the parts of it may adapt themselves, in the most perfect manner, to those of the subject, as well as be compact with respect to themselves. When the model is so covered to a convenient thickness, the whole must be left at rest till the plaster be so firm, as to bear dividing without falling to pieces; or being liable to be put out of its form by slight violence. It must then be divided into pieces; in order to its being taken off from the model, by cutting it with a knife, or with a very thin blade; and being divided, must be cautiously taken off, and kept till dry. But it must be always carefully observed before the separation of the parts be made; to notch them cross the joints, or lines of the division, at proper distances, that they may with ease and certainty be properly conjoined again; which would be much more precarious and troublesome without such directive marks. The art of properly dividing the molds, in order to make them separate from the model, constitutes the great object of dexterity and skill in the art of casting; and does not admit of rules for the most advantageous conduct of it in every case. But we shall endeavour to explain the principles on which it depends in such a manner, that by a due application of them, all difficulties may at any time be surmounted, and an expertness even of manner acquired by a little practice. With respect to the case in question, where the subject is of a round or spheriodal form, it is best to divide the mold into the three parts, which will then easily come off from the model: and the same holds good of a cylinder, or any regular curve or figure.

The mold being thus formed and dry, and the parts put together, it must be first greased and placed in such a position, that the hollow may lie upwards, and then filled with plaster commixt with water, in the same proportion and manner as was directed for the

bafting the mold : and when the caft is perfectly fet, and dry, it muft be taken out of the mold and repaired, when it is neceffary : which finifhes the whole operation.

This is all that is required with refpect to fubjects, where the fufaces have the regularity above-mentioned. But where they form curves which interfect each other, the conduct of the operation muft be varied with refpect to the manner of taking the caft of the mold from off the fubject or model ; and where there are long projecting parts, fuch as legs or arms, they fhould, as was obferved before, be wrought in feparate cafts.

The method of dividing properly the molds cannot be reduced, as already has been intimated, to any particular rules ; but muft depend in fome degree on the fkill of the operator, who may eafily judge from the original fubjects, by the means here fuggested, what parts will come off together, and what require to be feparated. The principle of the whole confifts only in this, that where *under-workings*, as they are called, occur, that is, wherever a ftraight line drawn from the bafis or infertion of any projection would cross the ftraight line ; or, as that is frequently difficult, the whole projection muft be feparated from the main body, and divided alfo lengthways into two parts. Where there are no projections from the principal fufaces, but the body is fo formed as to render the furface a compofition of fuch curves, that a ftraight line being drawn parallel to the furface of one part would be cut by the outline, in one or more places. of another part, a divifion of the whole fhould be made, fo as to reduce the parts of it into regular curves, which muft then be treated as fuch.

Where detached parts of a long form, as legs, arms, fpears, fwords, &c. occur in any figure, they fhould be caft in feparate molds : and if fuch parts are of a compound ftructure, the fame rules, as was before intimated, muft be obferved in the manage-

ment of them, as are already directed for the principal part.

In larger masses, where there would otherwise be a great thickness of the plaister, a corps or body may be put within the mold, in order to produce a hollow in the cast; which both saves the expence of the plaister, and renders the cast lighter.

This corps may be of wood, where the forming a hollow of a straight figure, or such as is conical with the basis outward, will answer the end. But if the cavity requires to be round, or any curve figure, the corps cannot be then drawn while intire; and consequently should be of such matter, as will suffer itself to be taken out piece-meal. In this case, therefore, the corps is best formed of clay: which must be worked upon wires to give it tenacity; and when the plaister is sufficiently set to bear handling, the clay must be picked out by a proper instrument.

Where it is desired to render the plaister harder, the water with which it is tempered should be mixed with parchment size, which will make it very firm and tenacious; the preparation for which is as follows

“ Take a pound of cuttings of parchment, or of
“ the leather used by glovers; and, having added
“ to them six quarts of water, boil them till the
“ quantity of the fluid be reduced to two quarts:
“ or till, on the taking out a little, it will appear
“ like a jelly on growing cold. Strain it through a
“ flannel while hot; and it will then be fit for
“ use.”

In the same manner, figures, busts, &c. may be cast of lead, or any other metal, in the molds of plaister; only the expence of plaister, and the tediousness of its becoming sufficiently dry, when in a very large mass, to bear the heat of melted metal, renders the use of clay, compounded with some other proper materials, preferable, where large subjects are in question. The clay, in this case, should be washed over till it be perfectly free from

gravel or stones; and then mixed with a third or more of fine sand, to prevent its cracking or instead of sand, coal ashes sifted till they be perfectly fine is preferable. Whether plaiter, or clay be used for the casting in metal, it is extremely necessary to have the mold perfectly dry; otherwise, the moisture being rarified, will make an explosion, that will blow the metal out of the mold, and endanger the operator, or at least crack the mold in such a manner as to frustrate the operation. Where the parts of a mold are larger, or project much, and consequently require a greater tenacity of cohesion of the matter they are formed of to keep them together, ruffs of cloth, or fine cotton, pluckt or cut till it is very short, should be mixt with the ashes or sand, before they be added to the clay to make the composition for the mold. The proportion should be according to the degree of cohesion required: but a small quantity will answer the end, if the other ingredients of the composition be good; and the parts of the mold properly linked together by means of the wires before directed.

There is another method of taking casts in metals from small animals, and the parts of vegetables, which, though not much known or used in this country, may be nevertheless practised for some purposes with advantage; particularly for the decorating grottoes or rock work, where nature is imitated. The proper kinds of animals are lizards, snakes, frogs, birds, or insects; the cast of which being properly coloured will be exact representations of the originals. This is to be performed by the following method. A coffin or proper chest for forming the mold being prepared of clay, on four pieces of boards fixed to-

together, the animal, or parts of vegetables, must be suspended in it by a string; and the leaves, tendrils, or other detached parts of the vegetables, or the legs, wings, &c. of the animals properly separated and adjusted in their right position by a small pair of pincers. A due quantity of plaister of Paris, and calcined talc, in equal quantities, with some *alumen plumosum*, must then be tempered with water to the proper consistence for casting; and the subject from whence the cast is to be taken, as also the sides of the coffin moistened with spirits of wine.

The coffin or chest must be filled with the tempered composition of the plaister, and talc. But, at the same time, a piece of straight stick or wood must be put to the principal part of the body of the subject; and pieces of thick wire to the extremities of the other parts; in order, that they may form, when drawn out after the matter of the mold is properly set and firm, a channel for pouring in the melted metal, and vents for the air; which otherwise, by the rarefaction it would undergo from the heat of the metal, would blow it out, or burst the mold. In a short time the plaister and talc will set and become hard; when the sticks and wires may be drawn out, and the frame or coffin, in which the mold was cast, taken away. The mold must be then put first into a moderate heat, and afterwards, when it is as dry as it can be rendered by that degree, removed into a greater; which may be gradually increased, till the whole be red-hot. The animal, or part of any vegetable, which was included in the mold, will then be burnt to a coal; and may be totally calcined to ashes, by blowing for some time gently into the channel and passages made for pouring in the metal, and giving it vent to the air; which will, at the same time, that it incinerates the remainder of the animal, or vegetable matter, blow out the ashes. The mold must then be suffered to cool gently; and will be perfectly the destruction of the substance of the animal, or vegetable, having produced a hollow of a

figure correspondent to it. But it may be nevertheless proper to shake the mold, and turn it upside down, also to blow with the bellows into each of the air vents, in order to free it wholly from any remainder of the ashes. Or where there may be an opportunity of filling the hollow with quicksilver without expence, it will be found a very effectual method of clearing the cavity, as all dust, ashes, or small detached bodies, will necessarily rise to the surface of the quicksilver; and be poured out with it. The mold being thus prepared, it must be heated very hot when used, if the cast be made with copper or brass: but a less degree will serve for lead or tin. The melted metal must be then poured on, the mold gently struck, and suffered to rest till it be cold. At which time it must be carefully taken from the cast; but without the least force. For such parts of the matter as appear to adhere more strongly, must be softened by soaking in water, till they be intirely loosened, that none of the more delicate parts of the cast may be broken off or bent.

Where the *alumen plumosum*, or talc, cannot easily be procured, the plaister may be used alone. But it is apt to be calcined by the heat used in burning the animal or vegetable from whence the cast is taken; and to become of too incohering and crumbly a texture. For cheapness, Stourbridge clay, or any other potter's or other good clay, washed over till it be perfectly fine, and mixed with an equal part of sand and some flocks cut small, may be employed. Pounded pumice stones and plaister of Paris, taken in equal quantities, and mixed with washed clay in the same proportion, is said to make excellent molds for this and parallel uses.

Casts of medals, or such small pieces, as are of a similar form, may be made in plaister, by the method chiefly made use of for bass relieves. And Indeed there is nothing more required than to form a mold, by laying them on a proper board; and, having surrounded them by a rim made of a piece of card or any

other pasteboard, to fill the rim with soft tempered plaister of Paris : which mold, when dry, will serve for several casts. It is nevertheless a better method to form the mold of melted sulphur ; which will produce a sharper impression in the cast, and be more durable, than those made of plaister.

The casts of medals are likewise frequently made of sulphur : which being melted, must be treated exactly in the same manner as the plaister.

Casts may be made, likewise, with iron, with very little additional trouble, provided it be prepared in the following manner.

“ Take any iron bar, or piece of a similar form ;
“ and, having heated it red-hot, hold it over a vessel
“ containing water ; and touch it very slightly with
“ a roll of sulphur : which will immediately dissolve
“ it ; and make it fall in drops into the water
“ under it : then as much iron as may be wanted
“ being thus dissolved, then pour the water
“ out of the vessel ; and pick out the drops formed
“ by the melted iron from those of the sulphur,
“ which contain little iron, and will be distinguish-
“ able from the other by their colour and weight.

The iron will, by this means, be rendered so fusible, or easy to be melted, that it will run with less heat than will melt lead ; and may be employed for making casts of medals ; and many other such purposes, with great convenience and advantage.

Impression of medals, having the same effect as casts, may be made also of isinglass glue by the following means. Melt isinglass, beaten as when commonly used, in an earthen pipkin, with the addition of as much water as will cover it, stirring it gently till the whole be dissolved. Then with a brush of camel's hair, cover the medal ; which should be previously well cleansed and warmed, and laid horizontal on a board or table greased in the part around the medal. Let them rest afterwards till the glue be properly hardened ; and then, with a pin, raise the edge of it, and separate it carefully from the medal ;

the cast will be thus formed by the glue as hard as horn; and so light, that a thousand of them will scarcely weigh an ounce. In order to render the Relief of the medal more apparent, a small quantity of carmine may be mixed with the melted isinglass; or the medal may be previously coated with leaf gold by breathing on it, and then laying it on the leaf, which will by that means adhere to it: but the use of the leaf gold is apt to impair a little the sharpness of the impression.

There is likewise a method of making impressions of the same kind in lead: which is this. Lay the medal on a post, or other firm body of wood; and cover it with a piece of very thin plate of lead; and lay over that another piece of thicker plate. Then place on them end-ways, a piece of wood turned of a round figure; which may be a foot or more in length; and of such thickness, that its diameter may be somewhat greater than that of the medal. Strike then forcibly on the upper end of the wood with a mallet, or some such instrument; and the undermost plate of lead will receive the impression of the medal: to preserve which, the concave of the reverse may be filled up with resin, mixed with an equal part of brick-dust, and melted. The impression should be made with one stroke; which will produce a sufficient effect, if given with due strength, and in a perpendicular direction. Impressions may be even taken from sealing wax or sulphur in this manner, if the pieces be no way bending on their under side.

Impressions of medals may be likewise taken in putty; but it should be the true kind made of earth of tin and drying oil. These may be formed in the molds previously taken in plaster or sulphur; or molds may be in its own substance, in the manner directed for those of the plaster. These impressions will be very sharp and hard: but the greatest disadvantage, that attends them, is their drying very slowly, and being liable in the mean time to be damaged.

Impressions of prints, or other engravings, may be taken from copper plates, by cleaning them thoroughly; and pouring plaister upon them; but the effect, in this way, is not strong enough for the eye: and therefore the following method is more preferable, especially where such impressions on plaister are desired.

Take vermilion, or any other coloured pigment, finely powdered, and rub it over the plate. Then pass a folded piece of paper, or the flat part of the hand, over the plate, to take off the colour from the lights or parts where there is no engraving. The proceeding must then be the same, as when no colour is used. This last method is also applicable to the making impressions of copper plates on paper with dry colours: for the plate being prepared as here directed, and laid on the paper properly moistened, and either passed under the rolling-press, or any other way strongly forced down on the paper, an impression of the engraving will be obtained.

Impressions may be likewise taken from copper plates, either on plaister or paper, by means of the smoak of a candle or lamp; if, instead of rubbing them with any colour, the plate be held over the candle or lamp, till the whole surface is become black, and then wiped off by the flat of the hand, or paper.

These methods are not, however, of very great use in the case of copper plates; except where impressions may be desired on occasions where printing ink cannot be procured. But as they may be applied likewise to the taking impressions from snuff-boxes, or other engraved subjects, by which means designs may be instantly borrowed by artists or curious persons, and preserved for any use, they may in such instances be very useful.

The expedient of taking impressions by the smoak of a candle or lamp may be employed, also, for botanical purposes, in the case of leaves; as I reflect

and durable representation of not only the general figure, but the contexture and disposition of the larger fibres, may be extemporaneously obtained at any time. The same may be, nevertheless, done, in a more perfect manner, by the use of linseed oil, either alone, or mixed with a small proportion of colour, where the oil can be conveniently procured. But the other method is valuable on account of its being practicable at all seasons, and in all places, within the time that the leaves will keep fresh and plump. In taking these impressions, it is proper to bruise the leaves, so as to take off the projections of the large ribs, which might prevent the other parts from plying to the paper.

Leaves, or also the petals, or flower leaves of plants, may themselves be preserved on paper, with their original appearance, for a considerable length of time, by the following means. Take a piece of paper, and rub it over with the isinglass glue, treated as above directed for taking impressions from medals; and then lay the leaves in a proper position on the paper. The glue laid on the paper being set, brush over the leaves with more of the same; and that being dry likewise, the operation will be finished: and the leaves so secured from the air and moisture, that they will retain their figure and colour much longer than by any other treatment.

Butterflies, or other small animals of a flat figure, may also be preserved in the same manner.

CHAP. XXV.

Of PYROTECHNY, or FIREWORKS.

To make a SKY-ROCKET.

PROVIDE yourself with a piece of good tough ash, or any other kind of wood that will not split; it must be six inches long, and when turned, two inches diameter. It must be bored, and the diameter of the bore one inch. Besides this, you must have a foot or bottom to the mold, which must be turned in such a manner as just to fit the bore of the mold (viz.) one inch; leaving the bottom part of the foot of the same diameter as the mold viz. two inches; and at the top of the foot which goes into the mold, must be turned a half ball, which is designed for the bottom part of the rocket-case, or choak, to rest upon, and must be the same diameter as the roller on which you roll the paper in making the cases. In the centre of the half ball must be fixed a strong iron pin, which, from the top of the ball, must be better than three inches long; it must be made taper, and at the bottom about the thickness of a goose quill: the upper end must have a small point; but see that the pin has a regular taper, and also mind that it is fixed exactly in the centre of the half ball, so that when the bottom is put to the mold, the point of the pin may be just in the middle of the bore. The design of this is to leave a hollow taper cavity when filled; and without which the rocket cannot possibly mount.

In the next place you must provide yourself with a roller to roll the paper on for making the cases. Let a turner turn you a piece of ash or box; it must be about eight inches long, and two thirds of an inch thick, on which must be rolled strong paper very tight till it will exactly fit the bore of the mold, which is done by having a board with a handle in the middle of it, so that when you have rolled your paper as firm as you can with your hands, then lay your roller upon a table, and put the board upon it, and with the whole weight of your body, run the board forward four or five times, and you will find this will make your paper as firm and hard as possible; but the rolling should be between every sheet of paper, with a little paste which will make it firmer. The paper must be six inches wide or better, which is the length the rocket should be. — You may make rockets of what size you please (these are called the small ones, and are most commonly used) observing, that, for every inch your rocket is made wide, it must be six times as long: and the larger they are, the less quantity of powder is required.

When you have rolled paper enough on your roller, so as to fit the cavity of the mold, then draw forth your roller about an inch, and put in a short roller, which you must have for the purpose, about two or three inches long, and of the same thickness as the long one, leaving a space between them about half an inch, when the case is to be choaked to straiten the cavity thereof; this is done by tying a piece of strong cord to a hook or staple in the wall, and take one turn round the space between the long and short roller, and choak it till the whole will just receive the taper pin; when done, tie it fast round with good strong packthread: then draw out your rollers with care, and when dry, it is fit for use.

The mold and case being prepared, the next thing to be considered, is the rammers to ram your composition with. You must get two pieces of good tough wood turned, so as with ease will pass up and down

the case; the long one should be about seven inches, the other not above half that length, as the short one will be better to ram with when the case is near full: they must be made hollow on account of the taper pin, which is fixed to the bottom of your mold, so that when you ram your composition, the hollow part of the rammer will receive the pin, by which means the rocket, when filled, will have a hollow cavity near two thirds up it, which (as observed before) is the chief reason of its mounting.

We now come to consider the composition for filling these small rockets, as follows: Take twelve ounces of gunpowder, two ounces of salt-petre, half an ounce of stone sulphur, an ounce and a half of charcoal, all ground together, and sifted through a fine sarge, so that no whole corns remain.—If you would have your rocket leave a long train put in a little salt-petre grossly bruised.

With this composition your cases must be filled, which is done in the following manner, fix your mold and bottom together, then take the case and put it into the mold, and put down the long rammer, and strike a blow or two, to settle the paper in its form: then proceed to fill it, by putting in about a tea-spoon full of the composition at a time, which must each time be rammed very hard with a mallet till your case is full. Then draw your rocket gently out of the mold, lest you should crush or break it, which would cause it to burst in firing.

Your rocket being filled, it should next be ornamented with stars, to take fire when the rocket is burnt: to make which, mix three ounces of gunpowder, one ounce of salt-petre, and a little crude antimony, all beaten to fine powder; moisten them with gum-water, and form them into little balls about the size of a nut, dry them in an oven or by the fire; inclose four or five of them on the top of your rocket, which is done by having a short case of paper just to fit the upper part of the rocket: when you have put

in your stars, inclose the top of the case — Some fix a conical cap on the top to make it pierce the air more quick.

To make the rocket mount straight up, it must be tied fast to a long slender stick, eight times its length; you must poise it, by laying it on your finger about an inch from the mouth, and if you find the stick too heavy, cut it off, till the stick preponderates a little; for was the rocket to over-balance the stick, it would not rise up, but tumble about in a strange manner,

To fire your rocket, take some cotton wick, washed in gunpowder and water, let it be well dried, and cut it into lengths of about three inches; take one of these and put it up the hollow part of your rocket, leaving the end to hang a little below the mouth: hang your rocket at freedom on a wall or post, and set fire to the fuzee, and if it has been properly managed, it will mount up a considerable height. — If you find the rocket burn out too fierce or burst in mounting, add a little powdered charcoal to the composition; and if too weak, add some mealed gunpowder.

SERPENTS are a kind of small rocket, and chiefly fired out of the hand; if you make them properly they exhibit a beautiful appearance, and will run backward and forward on the ground in a very curious manner.

The method of making them is nearly the same as the sky-rocket, observing that the bore of your serpent mold should be only half an inch, and the length six or seven inches: the bottom of the mold be turned in the same manner, but observe it must be no more than half the thickness; there is no necessity of an iron pin in making serpents, as they are not designed to mount up.

The thickness of the roller to make the cases should be about the size of a good large reed, and the rammer somewhat smaller; a rammer made of iron is much the best, as one of wood is rather too weak to ram them well. The serpent case must also be choaked, leaving only a very small cavity to receive a large knitting needle.

When your case is within two thirds of being full, then fill it up with corn powder, and secure the end as fast as possible, some only fill them half full of the composition, and put in more powder to make the report greater. When the serpent is filled, and taken out of the case, fill the cup where it is choaked with a somewhat weaker composition for priming, and tie a piece of touch-paper round the end, to prevent the priming from falling out.

The composition for making serpents, should be one pound of gunpowder, two ounces of charcoal, and a few steel filings to make it sparkle the more.—Some also use a little salt-petre which is not amiss; let them all be ground very fine and sifted.

OF FIRE-WHEELS.

Of these are three sorts, viz. single, double and triple; some of their fellies are of a circular form, others hexagonal, or decagonal; some like a star, without fellies. Most of these are made to run perpendicular to the earth, others parallel; and all may be ordered so as to serve on land or water.

The fire wheels that are to be used on land, turn on an iron pin or bolt, drawn or screwed into a post; the nave is turned of close or firm wood, in which the joiners glue the spokes according to the number of the fellies, which must be carefully joined together: then have a groove hollowed round, so deep that the rocket or case may be about half lodged therein.

The double wheels must have their fellies turned stronger and wider, with a groove for the rockets, not only at top, but also on one side thereof, inclining the necks of the rockets at top to the right hand, and those of the sides to the left.

A triple wheel has a groove at top, and one at each side; the matches are laid from one groove and rocket to another, with small pipes filled with meal powder. You may also make a triple wheel on a long nave, and observe the placing of the rockets on each, contrary one to the other; and the communication you are to make with small pipes, which, after they are fixed, you are to cover and glue over with paper.

Your rockets being ready, and cut behind a little shelving, bore them: the first three diameters off its orifice; the second two and three quarters, the third two and a quarter; the fourth two diameters, the fifth one and three quarters, the sixth one and a half; the seventh one and a quarter, the eighth one diameter; always the latter something shorter than the preceding: after this, they are primed with meal powder, worked up with brandy; and when dry, glued in the grooves before described. You must bear the first fired rocket's neck up above the rest, underlaying it with a tin plate, or any thing else: the same must be observed in the last fired one, wherein you put the charge of a report. You may also glue, on every end of the rockets, a report of paper, with small copper pipes or goose quills, which are fixed one end in the rocket and the other in the report. When all is dry, then you may cover your wheel, on one or both sides, with linen or paper, in what form you would have it. The horizontal or parallel wheels, are made like the others with fellies, or of one entire piece: their grooves are furnished with rockets, and their planes with crackers.

rock water, one ounce of oil of bette, one ounce of lin-
campfire, one ounce of oil of bette, and two
seed oil, half an ounce of oil of bette, and two
ounces of colophonia.

Of WATER-BALLS.

Balls in fireworks are of different forms; some are globular, some oval, some conical, some cylindrical, and others in the shape of a pendant or drop. The water-balls are commonly made of knitted cord bags or of wood; those made of bags are shaped like ostriches eggs, and are filled with their proper charge, the outside is dipped in glue, and wound about with hemp or flax, till it is a quarter of an inch thick thereon; this ball is then coated over with cloth; and about the touch-hole, glued over with a piece of leather; the touch-hole is bored with a gimlet, and stopped with a wooden peg; at the bottom of the ball pierce a small hole through to the composition, in which fasten a small copper pipe, furnished with a paper report, together with a leaden balance; glue the report fast to the ball, then dip the ball in melted pitch, open the touch-hole, and prime it with a quick burning charge. These balls keep a long time under water before they rise, and, if a true balance is not observed in the lead, or the ball be over charged, they will sink to the bottom and burn out; therefore you must well observe, that when a water ball, without the balance is two pounds weight, you must give it four, or four ounces and a half of lead; but, if it weighs one pound and a half, balance it with three, or three ounces and a half.

Charge for the FIRE-BALL.

For every pound of powder, take eight ounces of rock water, four ounces of sulphur, two ounces of camphire, one ounce of oil of petre, one ounce of linseed oil, half an ounce of oil of spike, and two ounces of colophonina.

*How to make Fireworks to run upon a line backward
or forward.*

Take small rockets, and place the tail of one to the head of the other, tying a cane to run on a line sloped; the line may be a hundred yards long or longer if desired, being well stretched and set on stakes; and at last (if you please) may be placed a pot of fireworks, which being fired off will make good sport; having serpents and other things in it, which will variously intermix themselves in the air, and upon the ground, and every one will extinguish itself with the report.

How to make a CRACKER.

Take of strong cartridge paper a piece six inches wide the length of the sheet, and fold down the breadth of three quarters of an inch, then double back half that breadth to crease the paper, open that double again, and put in your charge, which must be meal powder, and for your fuzee take a piece of cotton wool rolled in meal powder, and place it in the end before you proceed to fold up your paper, that it may not be lost: then close the double you opened very flat which will prevent the powder from escaping into other folds, then roll it up one double after another, pressing each fold down with the hand to make it smooth and flat, till you have rolled up all the paper: then proceed to fold up the length of the paper (first securing one end of the cracker so as no powder can get out) about two inches long each fold, till you have folded the whole, then twitch all the parts together with fine strong twine, and then once between each double, in order to make it look neat, then beat it flat with a hammer; and when fired, if well managed according to the directions, you will have a good explosion between each fold.

CHAP. XXVI.

The Art of making Porcelain after the Chinese Manner.

THE most just and regular idea we can form of the Porcelain, or China Ware, is, that it is an half vitrified substance, or manufacture, in a middle state between the common-baked earthen-ware of our vulgar manufactures and true glass; this is the essential and distinguishing character of Porcelain, and it is only by considering it in this light, that we are to hope to arrive at the perfect art of imitating it in Europe.

This attempt is to be made, on these principles, and in two different manners: The one, by finding some appropriated matter, on which fire acts with more than ordinary strength, in the time of its passing from the common baked state of earthen ware into that of a glass; the other is to compose a paste of two substances reduced to powder, the one of which shall be of force to resist a very violent fire, so as not to come vitrified in it; and the other a matter easily vitrifiable: in the first case the matter is to be taken out of the fire, at the time when it is imperfectly vitrified; and in the other the compound mass is to remain in the furnace till the one substance, which is the more easily vitrifiable, is truly vitrified, and being then taken out, the whole will be like what Porcelain is, a substance in part vitrified, but not wholly so.

The first method is, that by which the European Porcelain has generally been made; and though that of St. Cloude and some other places has been very beautiful, yet it is always easy to distinguish even the finest of it from china ware, and the nature of the two substances appears evidently different; these, owing all their beauty to their near approach to vitrification, are made to endure a long and violent fire, and are taken from it at a time when a very little longer continuance would have made them perfect glass; on the contrary, the china ware being made of a paste, part of which is made of a substance in itself scarce possible to be vitrified, bears the fire in a yet much more intense degree of heat than ours, and is in no danger of running wholly into glass from it.

The two substances, used by the Chinese, are well known by the names of petuntse and kaolin; and on examining these, it appears very evident, that we have in Europe the very same substances, or, at least, substances of the very same nature, and capable of being wrought into a Porcelain equally beautiful and fine.

These are the two different semivitrifications, on one or other of which all the European manufactures have hitherto been founded; and it is easy, from the knowledge of these two principles, to determine, on breaking a piece of the china of our manufacture, by which of the two processes it is made. It is done by fixing the half vitrified mass of a substance which would soon after have been wholly vitrified; then the putting it in a crucible, into an equal degree of fire, will soon turn it wholly into glass; this is the case of most of our European Porcelain. But, if it is made of two ingredients, the one of which is not vitrifiable, or at least not by such fires, then the matter will melt, but will not vitrify; this is the case with the Chinese Porcelain, which is

kept in fusion a long time, yet, when cold, its China-ware still, so that this is evidently made of two such ingredients.

Besides these methods, yet there is another of late invention, which makes a very beautiful china, and which, if it does not afford vessels equal to those of china, yet will afford them nearly approaching to those, and at a considerably smaller price: This method consists in reducing glass to china.

The fine deep blue of the old Porcelain ware of china is much valued by the curious, and it is much lamented that the same colour is not used at this time.

The art seems at present to be lost, but perhaps it might be recovered by trials; it is certain, that the Chinese have cobalt among them, and very probably they used a blue colour prepared from this, before they had any commerce with us; notwithstanding all the conjectures about their materials for colouring, this seems the most probable substance; and there is a way of preparing a colour from this, much superior to that now in use, which we call smalt.

Cobalt is a mineral containing arsenic and a vitrifiable earth. The common way of preparing smalt is by roasting this cobalt in a reverberatory fire. This disposes it to vitrify, and drives off the arsenic it contains in fumes, which, collecting at the top, forms true flowers of arsenic. It is very certain, however, from experiments, that, if this arsenic could be presented by the cobalt, the smalt would be of a much finer colour; for there are some kinds of cobalt, which yield smalt without previous roasting; and, as the arsenic is in a great measure contained in these, the smalts are much finer coloured. Arsenic, added to smalt while in fusion, greatly exalts its colour above so; and there is a way of producing smalt from cobalt

without fire, only by dissolving it in an acid, and precipitating that solution with oil of tartar; the smalt, thus precipitated to the bottom, is of a much finer colour than any prepared by fire, but it is much more expensive, and prepared in less quantity. It is very possible that the Chinese might have the art of making this kind of smalt before they knew us, and that to this was owing the fine blue of their Porcelain ware; but when we trafficked with them, and they purchased smalt so much cheaper of us, than they could make it themselves, they naturally discontinued the manufacture of their own finer kind, without considering how greatly inferior that colour was, which the other yielded. If this be the case, it will be easy to revive this other art; and the adding the true old china blue to our European manufactures, in imitation of Porcelain, may give them a value which they have not at present.

The Chinese had once a method of painting the figures of fishes and other things on the inside of their vessels, in such a manner that they did not appear till the vessel was filled with water, or some other clear liquor; they called this sort of China ware *kialsim*, that is to say, the concealed blue china. The art is now in a great measure lost, but there may be some guess made at the manner in which it might be done at this time. The vessels that are made in this manner, must be very thin; the colour must be laid on in the form of the fish, or other animals, or figures on the inside, after the vessel has been once baked; after this colour has had time to dry, the inside of the vessel must have a second colour of the same earth, or stone, of which the vessel is made, and over this a varnish of the common kind; the consequence of this will be, that the figures of the fish in a very strong colour will be buried between two coats of the ware, which together form a complete vessel; the outside is then to be ground down almost to the figures, and

when they begin to appear, a new coat of varnish, may be laid over this; the figures will then be obscure, and scarce if at all perceivable; but, on filling the vessel with water, the transparence of the sides will be taken off, and the liquor will make a sort of foil behind, which will throw out the figures of the fish; this might be done in any ware clear and transparent; the Porcelain of China would best succeed with it, but the pains and nicety required are too great.

The Chinese make a variety of figures on the surfaces of the vases of white china ware, and there is one kind of this greatly in esteem among them, in which there are flowers and other figures, yet the surface is quite smooth, and the substance extremely thin; the manner of making it is this: They first form the vessel of the finest materials as thin as they can; then, when they have polished it inside and out at the wheel, they put it into a stump of its own shape, but cut with all these figures; they press this down so firmly on this yet moist vessel, that the impression is received in a very perfect manner; and, if the shape of the vessel be at all lost, they take it to the wheel again to restore it: they then finish it with the knife and scissars, and, when they have made it as perfect as can be, they cover it with a fine white varnish, within and without; this fills up all the cavities of the impression, and gives a perfectly smooth and even surface; yet the thickness of this varnish in the traces of the figures gives it a different white, and the whole figures are as finely and accurately seen as if painted on the outside; this is an artifice that might easily be brought to bear among us, and several of our finer wares would make a pretty figure with it.

There is a current opinion among the Chinese themselves, that the Porcelain ware of former times was greatly superior to that which they make at pre-

lent; and that the burying china in the earth for a long time adds to its beauty; but all this is founded on error. The truth is, that our merchants beat down the price of their ware, and thereby compel them to make a worse kind in general; but they are able to do as fine things now as ever.

What gave birth to the opinion, that burying the Porcelain made it good, was, that finer pieces than ordinary are sometimes found buried; these are all precious vases which the possessors bury by way of security, in the times of civil war; and it is no wonder that there are none but the finest kind found buried on these occasions.

Staining or colouring Porcelain.

The Chinese, for a great many ages, used only white Porcelain; the first colour they employed was blue, and, after that, made use of many more; the ancient blues were prepared by themselves from a kind of lapis lazuli, but we now supply them with the smalt so much cheaper, that it is no longer worth their while to make it themselves; they used to prepare this only by giving a gentle calcination to the stone, and then beating it to powder, and grinding it to the utmost fineness in mortars of unglazed Porcelain ware with pestles of the same. The red, that the Chinese use, is made of our green vitriol, or common copperas; they put about a pound of this into a crucible, and into on this another crucible inverted; this last has a hole cut in the top, which they keep covered or open at pleasure. They set this crucible in a furnace of bricks so contrived, as to throw all the flames upon the lower vessel, in the way of our chemists reverberatory furnaces; they make a large fire of charcoal all round it, and observe the hole at the top; so long as there ascend thick black

fumes through that, the matter is not sufficiently calcined, they watch the going off of this fume, and when there appears in the place a fine and thin cloud, they take away the crucible; the matter being then sufficiently burnt, they try this however by taking a little out, and examining the colour; if it be not sufficiently red, they let it remain longer in the fire; when they find that it is of a good colour they take away the fire, and leave the vessel to cool; this done, they find a cake of red matter at the bottom of the crucible, and a quantity of finer powder about its sides; they keep these separate, the latter being the purest, the finest, and the brightest colour; one pound of copperas affords about four ounces of this colour, and this is the red, which they manage in different shades and vary so much.

The Chinese have also a white colour, which they use in their figures painted on the china; the ware itself is naturally white, and the varnish, or oil of stone, is a great addition to its whiteness all over. But they have yet another way of making a much finer and brighter than these, as may be seen in most of the fine china ware, where there is any white in the figures; this white is made in the following manner; They collect on the shores of their rivers a sort of agate, which is of a whitish hue, without veins, and tolerably transparent; it approaches very much to the nature of chrystal, and probably chrystal may be found to supply its place with us; they calcine this stone to white powder, and to every ounce of this, when ground in Porcelain mortars to an impalpable fineness, they add two ounces of ceruss in fine powder, this they mix with varnish, and lay on in the common way of other colours.

This white mixture serves not only for the colouring white, but it is the basis of several other of those beautiful colours which we see on the china ware, and which our manufacturers have been often per-

plexed what to make of; their green colour is made of copper rusted with acid; and the fine deep violet colour is made of this green, by adding to it a due proportion of white; it is not to be supposed, that this effect is to be produced according to the common laws of mixing colours among painters, for then the white and the green would only make a paler green. But, copper being a metal, that as well gives a fine blue as a fine green, according to the nature of the substances it agrees with, the white in this case alters the very nature of the green, and converts it into that deep and fine violet blue which we may draw from copper, by means of any of those volatile alcalies, such as spirit of sal armoniac, spirits of hartshorn, spirit of urine, or any the like liquor..... The workmen know how to bring this blue to any degree, by putting in different proportions of each colour; there is not any admixture of them that will not produce a blue of some kind, but always the more of the green colour is used, the deeper the blue is, and the less the paler; the yellow is made by an admixture of seven drachms of this white, and three drachms of copperas, or more, if they desire the colour to be deeper.

These colours are laid on upon the vessel, when they have been once baked; but they do not appear, till the second baking is over, in their proper shades and tinges, and sometimes scarce at all.

The black china is much esteemed in the east, and particularly when it is ornamented with gold, this colour looking better with that ornament than any other; the black is always laid on when the Porcelain is first dried, and is prepared by mixing of a fine deep blue, with seven ounces of that fine varnish, which they call oil of stones. This admixture gives a deep black, when the colour is thoroughly dry, the vessels are baked, and when this is done, the gold is laid on, and the whole is baked again in a particular

furnace made for that purpose; if they would have the black degenerate into blue, they need only add the less of the blue, and a little of the ceruss, or agate white before described. They have two peculiar ways of applying the red, besides the common one, both which require a nice workman, and make the ware come very dear; they call one of these oils red, and the other blown red.

There are many things practised by the Chinese, in their colouring and forming the several kinds of Porcelain, which may be well brought into use among us, and give a new value to our own wares, even though we should never arrive at their art of making the thing itself.

One kind of colouring easily introduced among us, would be what they call hoan-ton hoan; this produces vessels of great beauty and price, and is done in this manner: The matter of which vessels are made for this purpose, need not be very fine; they usually take any of the common vessels baked, without having been varnished, and consequently simply white, and without lustre: when these are intended to be of one simple colour, they need only be plunged into a liquid varnish or oil, as the workmen there call it, coloured with such ingredients as will strike the most lively tinges: but if it is to be coloured in compartments, as is usually the custom with this sort of china, it is to be done by the pencil; the usual way is to paint these in pannels, one green, another blue, and so on; and they make a very agreeable appearance.

There requireth no more to this, than the laying on the colours tolerably thick with a large pencil; but if the pictures of animals and plants are to be given, they are to be done with the most permanent colours, and the vessel being again well baked, becomes very beautiful.

The Chinese who are deceivers in every thing, find the way of cheating very much, in regard to this sort of china ware; they paint the flowers of plants, and some parts of the birds, &c. in very bright colours, after the vessel has been baked. Vermillion is a fine colour, which they often add on this occasion; but they cannot use this before the baking, because it would be destroyed by the fire; these colours, which are laid on afterwards, cannot last, but soon rub off in wiping, or using the things; the others last for ever, for they are laid on with the greatest heat of all, the vessels being put into the same furnaces to lay on these as the other things are baked in, for the first time. Saltpetre and powder of flints are the things generally added to the colours thus laid on, to make them penetrate and run properly. Thus for the fine deep violet colour, which makes the greatest figure of all others; on this ware they mix together equal quantities of the fine azure, the powder of flints, and saltpetre, all first powdered separately, till perfectly fine: this is tempered with water, and then laid on with the pencil; and tho' it looks rough at first, it comes out of the furnace of as beautiful a glossy hue, as any thing that can be conceived. The yellow is made by mixing together three ounces of ceruss, and three ounces of powdered flints, and adding three, four, or more drachms of the red copperas, till the whole is of a proper degree of colour. The white is composed only of powder of flints and ceruss, with a small admixture of the salt-petre, or it will succeed tolerably well without; these are all the particulars necessary to be observed, for the making a sort of porcelain of great beauty, in which the nature of the ware itself is not concerned; so that it seems easy to imitate it with any of our own wares.

In the baking of this or any other kind of coloured china, the second time, there is however some caution to be used in the placing of the pieces; the

Chinese are very curious in their disposition of these, arranging them in the most compact manner, and putting the little ones within the great ones; great care is also necessary, that the vessels do not touch one another in the parts where they are painted; for the consequence of that would be the spoiling of both vessels, as the colours would run together; the bottom of one vessel may generally be placed on the bottom of another, though both are painted; because the rims are not painted, and they keep the painted parts from touching one another. High and narrow vessels, such as chocolate cups, &c. are very troublesome on this occasion; the method the Chinese workmen take with them is this: They place a range of them so as to cover the whole bottom of the furnace, and they cover this with a thin bed of broad china ware, over which they place a thin row of cups, and so on to the top, where they lay on covering; they never bake any thing else with those cups, when they are of this kind of twice-baked Porcelain.

As the Chinese are very curious in their disposition of these, arranging them in the most compact manner, and putting the little ones within the great ones; great care is also necessary, that the vessels do not touch one another in the parts where they are painted; for the consequence of that would be the spoiling of both vessels, as the colours would run together; the bottom of one vessel may generally be placed on the bottom of another, though both are painted; because the rims are not painted, and they keep the painted parts from touching one another. High and narrow vessels, such as chocolate cups, &c. are very troublesome on this occasion; the method the Chinese workmen take with them is this: They place a range of them so as to cover the whole bottom of the furnace, and they cover this with a thin bed of broad china ware, over which they place a thin row of cups, and so on to the top, where they lay on covering; they never bake any thing else with those cups, when they are of this kind of twice-baked Porcelain.

In the baking of this or any other kind of colour, the second time, there is however, some caution to be taken in the placing of the pieces; the

C H A P. XXVII.

Secrets relative to M E T A L S.

A secret to cause the transmutation of iron into the finest German steel.

TAKE of clean foot one pound, oak-wood alhes twelve ounces, and four of pounded garlicks. Boil all together in twelve pounds of common water, reduced to a third, or four pounds. Strain this, and dip in it the iron pegs, which you will afterwards stratify with the following cement.

Take burnt wood's coals, otherwise called cokes, and quick lime, of each three pound: foot dried, and calcined in an iron pan, one pound: decrepitate salt four ounces. Make of this and your iron several beds alternately one over another; and, having well luted the vessels in which you shall have made those beds of iron and cement, give them a reverberating fire, for three times twenty-four hours, and the operation is done.

To make Tin.

Take a discretionable quantity of rye-bran quite pure, boil it a minute or two in vinegar, then add to it a little water, and in that same instant plunge your sheets of black iron: then take out of the fire, and stop well, the vessel. Let your iron rest there and soak for twenty-four hours, after which time take off your iron sheets; scour them well with the very bran with

which they have been soaking, then rub them over a little with grindstones. This being done, let them soak again in a water wherein you shall have dissolved some amoniac salt, whence, having taken them off, set them to drain, and rub them afterwards with rye-bran, and your tin will be done.

Observe that the vessel in which you lay your sheets to soak, must be large enough to receive them in their full intended size.

To compose a metal of a Gold colour.

Take refiner's copper six ounces: melt it in a crucible; add one ounce of calaminary stone; half an ounce of tutty, and one of terra merita, in powder. Give to this a melting fire for five or six hours running, and no more: then take off the crucible from the fire. Put this composition in powder, and add to it two ounces of common mercury, six of sea-salt exsiccated, and a sufficient quantity of water. Set the whole a-boiling, until there appear no more mercury. Then put the matter into a crucible, and place it between two fires of kindled coals, avoiding carefully the breathing of the fumes. Give this a melting fire, for two hours, then wash the composition in water, till this runs off quite clear. Set this again in a crucible: and, when melted, pour it into an ingot. This will give you a metal of the most beautiful gold colour which can be desired, and which you may make use of for plates, buckles, snuff-boxes, cane-heads. But we cannot recommend too much the avoiding of breathing the fumes of this composition, while it is making.

To increase the virtues of a loadstone.

You must soak it, for forty days, in iron-oil.

To extract Mercury from Lead.

Take pearl ashes one pound, vine ashes four, quick lime one, and pebbles calcinated two. Make a strong lye of the whole with distilled vinegar. Dissolve in this two pounds of lead: and, when the lye is become white, throw in two ounces of borax. When this is dissolved, throw the whole into a retort, and distil it with a gradual fire. You will get, into the receiver, ten ounces, at least, of quicksilver.

Permutation of Lead into Silver.

Take fine lead; calcine it with common salt, or else, with that sort of salt which is extracted from the dregs *feces*, or *caput mortuum* of salt-petre and vitriol calcined both together. Soak the whole warmly with oil of vitriol till you make it come into an unctionous paste. This you will put into a pot or crucible, well luted, and placed in a pan full of sand, with which you will cover it over entirely. Make under this a digesting fire; that is to say, such a fire as is necessary to warm the sand: keep it so for ten days, then take off your matter and test it. Cut off one hundred and five pounds weight of lead, you will draw five marcs, or two pounds and half weight, of silver capable to stand the test.

Fixation of Salt-Petre.

Melt some lead in a crucible, and project on it pulverised nitre, reiterating the projections in pro-

portion as the matter fuses, till the whole is entirely melted.

Transmutation of Iron into Copper.

Iron is easily changed into copper, by means of the vitriol. To do this you put your iron *stratum super stratum* in a descensorium, and set it over a strong blatt fire, pushed by bellows, till the iron melts and flows into copper. You must not forget when you have made your beds of vitriol, to water them a little over with vinegar saturated of salt-petre, alkaline, and tartar salts and verdigrease.

To preserve the brightness of Arms.

Rub them with hart's marrow. Or else, dissolve some allum-powder with the strongest vinegar you can find, (that of Montpellier which serves to make their famous verdigrease is the fittest) and rub your arms with it. By these means they keep for ever bright and shining.

To soften Steel.

Take a discretionable quantity of garlic, rob them of their coarsest peel, then boil them in oil of nuts till reduced into an *unguentum*. Cover well your steel all over with that composition to the thickness of half a crown. When this is done, put your steel, thus covered, in the forge, in the live coals, and it will become soft. To restore it afterwards to the temper, called by artists red cherry colour, you must after having made it red hot, plunge it in the coldest water.

To extract Mercury from Antimony.

Take antimony and decrepitate salt, of each one pound. Mix them together, and put in a retort of two quarts. Set the retort on the bare fire, or on the gradual sand fire. Let the beak of the retort be in water, and at the bottom of that vessel, wherein the water is, you will find the running mercury of antimony.

To whiten Copper, so as to make very fine Figures with it.

Take five parts of copper, which you will melt in a crucible, then throw in one part of zine. As soon as the zine is in it, take it off from the fire, and stir the matter a little with an iron rod, then cast it in the molds of your figures. They will look like silver casted ones.

To imitate Tortoise Shell on Copper.

Rub copper laminas over with oil of nuts, then dry them over a slow fire supported, by their extremities, upon small iron bars.

To perform the same on Horn.

Make a cold dissolution of auripigment in filtered lime-water: then lay some of this liquor with a

brush on your comb or other horn work. Reiterate this, if you find it has not penetrated enough the first time, and turn it to do the same on the other side.

To soften Metals.

Take salt-petre and camphire equal parts. Dissolve them in a lye made with two parts of oakwood ashes and one of quick lime. Pass this solution thro' a filtering paper, and vaporise it over a slow fire in a glass vessel. There results a borax which, thrown in metals while in fusion, softens them perfectly.

To wash Brass Figures over with Silver.

Take one ounce of aqua-fortis. Dissolve in it over a moderate fire one drachm of good silver cut small, or granulated. This silver being wholly dissolved, take the vessel off from the fire, and throw in it as much white tartar as is required to absolve all the liquor. The rest is a paste with which you may rub over any work made of copper, and which will give it the colour of silver.

To take immediately rust from Iron.

You must rub your iron with a piece of rag steeped into oil of tartar *per deliquium*.

To obtain good Silver from Pewter.

Take quick lime made from rock or transparent pebbles, and one pound of common salt. With those

two ingredients make a strong lye which you will evaporate on the fire to the reduction of a third part of what it made before. Next, melt in a crucible two pounds of pewter, to which, after fusion, you will add one pound of *hematites*. The whole being well incorporated and melted, throw it in part of your aforesaid lye: and, when quite cold, melt it again, and throw it again into new lye, repeating the same process for seven different times, and using fresh lye, prepared as above, every time.

To soften Iron.

Take half an ounce of tartar, two of common salt; and two and a half of verdigrease. Mix all together, and expose it in a porringer to the dew of nine nights running. This will turn into water, in which, when red hot, you may kill your iron.

To soften all Sorts of Metals.

Take sublimated mercury, euphorbium, borax, and armoniac salt, of each equal parts pulverised. Project some of that powder over any metal when in a state of fusion, and you will obtain the desired effect of making it soft.

A good Temper for Arms.

Take nettle's juice, bullock's gall, child's water, or strong vinegar, and a little salt. Incorporate well all this together, and plunge any red-hot iron into it.

To whiten Iron like Silver.

Melt iron filings in a crucible, along with realgar or red arsenic. Then take one ounce of that matter and one of copper; melt all together, and put it into a copper. It will give you one ounce of good silver.

A Spirit which will dissolve all Sorts of Stones, without excepting the most hard.

Take one pound of decapitated, or well purified copper, which you will melt; then throw over it 3 pounds of refined pewter. As soon as they shall be both in good fusion, add six ounces of calcined red tartar, two of arsenic, half an ounce of salt-petre, and two drachms of allum. Leave all this in fusion together for the space of three, or four, hours, that all the salts may well evaporate, then you will cast this composition in the flat sand mould prepared for it.

To guard Iron against rusting.

Warm your iron till you can no more touch it without burning yourself. Then rub it with new clean white wax. Put it again to the fire, till it has soaked in the wax. When done, rub it over with a piece of serge, and the iron will be preserved from rusting.

To cut pebbles with ease.

Boil them a good while in some mutton-suet ; and, then you will cut them very easily.

To make a perpetual motion.

Take aqua-fortis, in which you will throw some steel-filings well dried, Leave this mixture to lay for eight hours: then pour out the aqua-fortis in another bottle, in which you will throw a small load-stone of good quality, and stop it well that no air get in : you will then observe a perpetual motion.

To calcine Pewter, and render it as white and as hard as Silver.

Melt well your pewter in a crucible, so that it may be very fine and clear. Pour it afterwards into a very strong vinegar, then into mercurial water. Repeat that operation as many times as you please, you will each time give it an additional degree of hardness and whiteness, drawing near to silver ; so much, that it will, at last, be very difficult to distinguish it from silver itself.

To take away the brittleness of any Metal.

First calcine the metal, and put it under dung; and afterwards heat it red hot at the fire, or melt it, and quench it often in aqua-vitæ often distilled; or use resin or turpentine, or the oil of it; or wax, suet, euphorbium, myrrh, or artificial borax: For, if metals be not malleable, unctuous bodies will oftentimes make them softer.

If either all these, or some of these, be made up with some moisture into little cakes, and when the metal yields to the fire, by blowing with the bellows and some of them be cast in, and be made thick like mud, or clear; then set the metal to the fire, that it may be red hot in burning coals; take it out, and quench it in them, and so let it remain for half an hour to drink in.

Or daub the metal with dog's grease, and melt it with it: for that will take away much of the brittleness of it, and to make it so that it may be hammered and wrought.

To Colour Metal like Gold.

Take sal armoniac, white vitriol, rock salt, and verdigrease, of each a like quantity in fine powder: lay it upon the metal; then put it into the fire for an hour, take it out, and quench it in urine, and the metal will have the colour of gold.

To melt Metals quickly.

Put in a layer or course of the powder of any metal into a crucible; then lay upon it a layer of sulphur, salt-petre, and saw-dust of each a quantity, mixed together; put a coal of fire to it, and the metal will immediately be in a mass.

Of METALS in general.

METALS are simple fossil bodies, which fuse and become fluid by fire, and coagulate by cold, and harden into a solid mass, capable of distending under the hammer.

A Metal is said to be simple, as it may be affirmed of every the minutest particle of a metal, e. gr. a grain of gold, that it is gold, or has all the properties of gold.

A Metal is fusible by fire : that is, when exposed to a great fire, it dissolves into parts, which are easily moveable among themselves, or are actually in motion.

A metal is fixed, that is, it bears the fire without flying off in vapours. Though metals are fixed only to a certain degree ; for by the large burning-glasses of M. Tischernhausen and Vilette, all metals will readily evaporate.

Such are the proper characteristics of metals, which are no ways applicable to any other bodies in nature : for a diamond, or other stone, though it be a simple body, yet is not fusible in the fire, nor capable of being extended under the hammer ; and the salt, being dissoluble by fire, is not malleable, but will break under the hammer.

There are, indeed, certain woods, which yield, in some measure, to the hammer ; but then they fall to dust in the fire, and so of the rest.

There are but six metals found in all nature, viz. gold, silver, copper, tin, lead and iron.

To these is usually added a seventh metal, namely, mercury, or quicksilver, but improperly, as it has not all the characters of a metal, nor scarce any thing in common with the other metals, except weight and similarity of parts.

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Thus, for example, it is neither dissoluble by fire, malleable, nor fixed : And, in reality, it seems to constitute a peculiar class of fossils, and is rather the mother or basis of all metals, than a Metal itself.

The common radical character of metals is, that of all known bodies they are the heaviest.

By the experiments made by Dr. Halley, the weight of gold to that of glass is determined to be as seven to one ; and the weight of tin the lightest of all metals, to that of gold, as seven to nineteen ; which considerably surpasses the weight of all stones, marbles, gems, and other the most solid bodies, as appears from the tables of specific gravities.

Nor is there any body in nature, but a metal, that is one third of the weight of gold.

The Royal Society furnish us with various experiments of the kind.

The weights of the several metals and other solids they have examined hydrostatically, by weighing them in air and water ; and the weight by the fluids, by weighing an equal portion of each.

By such experiments they find, that, taking the same weights of water and gold, the bulk or magnitude of the water is to that of gold, as 19636 to 1000 ; consequently that the weight of gold is nearly nineteen to one.

The specific Weight of the several Metals, by this means determined, stand thus :

Gold	19635	Iron	7852
Quicksilver	14019	Tin	7321
Lead	11341	Stone	2000
Silver	105135	Water	1000
Copper	8843	Air	

The Cubic Inch of Ounces. Drachms. Grains.

Gold	} weighs	12	2	52
Quicksilver		8	6	8
Lead		7	3	30
Silver		6	5	28
Copper		5	6	36
Iron		5	1	24
Tin		4	6	17



F I N I S.